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NEW CONCEPTS OF CRYSTAL STRUCTURE

As is well known, the theory of crystal structure was worked out by Sohncke, Schoenflies and Federov in the 19th century on a purely geometric basis long before the discovery of the diffraction of X-rays by crystals opened up the possibility of the physical exploration of their atomic structure. The results of the geometric theory are embodied in the statement that any crystal must belong to one of the 230 possible space-groups, which in their turn are derivable from the 32 possible point-groups or symmetry classes to which a crystal can be assigned; these symmetry classes can be grouped together so as to yield the well-known classification of crystals into six (or seven) divisions. The theory of space-groups rests on the premise that the structure of a crystal exhibits the translational symmetry of a space-lattice or three-dimensional network of equally spaced points; a number of such lattices similar and similarly situated but not coincident interpenetrate each other, and the structure of the crystal is obtained by locating a set of atoms of the same kind at all the points of each such lattice. The enumeration of the possible space-groups is based on a consideration of the various types of symmetry which could be exhibited by such a structure. In passing from the point-groups to the space-groups, some additional types of symmetry become possible, *viz.*, glide-plane reflexions and screw-axes, the effect of which is to multiply the number of lattices which are occupied by atoms of the same kind and to locate these atoms within the unit cell of the structure at equal intervals which are integral submultiples of the lattice spacings. The theory of space-groups is complete in itself and its conclusions are fully borne out by the results of the X-ray investigations made with crystals. The determination of the space-group to which a crystal belongs is possible by X-ray study, the so-called absent reflexions giving the clue to the existence of glide-plane reflexions and screw-axes as elements in the symmetry of the structure. Indeed, assignment in this manner of the crystal to the space-group to which it belongs is a necessary step in the task of completely elucidating its structure.

While the complete generality and utility of the theory of space-groups are unquestionable, the nature of the approach which it makes to the subject of crystal structure is purely formal and geometric, and hence the theory cannot take us far towards a physical understanding of the facts of crystal structure. It

only tells us what combinations of the various elements of symmetry are possible and the results of such combination, but is not concerned with the reasons for their appearance. A characteristic feature of the theory of space-groups is the introduction, in all except some special cases, of undetermined parameters in the description which it affords of crystal structure. The appearance of unknown quantities in the description of a structure characterised by perfect order and symmetry must be considered a disturbing and unsatisfactory feature and is an indication that the foundations of the theory have not been laid deeply enough in the groundwork of physical reality.

An Alternative Approach

It is proposed in the following to put forward tentatively a concept of crystal structure which, while it is radically different from that forming the basis of the theory of space-groups, does not come into conflict with the results of that theory, but on the other hand, affords a physical interpretation of them, and also explains many facts known regarding the structure of crystals which have hitherto remained without adequate explanation. The concept proposed may be stated in the form of four propositions or postulates.

I. All the atoms in a crystal whether of the same or of different kind are located at the points of a common space-lattice: but not all the points of the lattice are necessarily occupied.

II. The locations of the atoms at the points of the common space-lattice with respect to each other are determined by fixed rules derived from their mutual affinities.

III. The unit of the structure which results from the grouping of the atoms around each other at the points of the common space-lattice is of the same species as the cells of that lattice, but its dimensions are integral multiples of the cell dimensions.

IV. The valence directions in the crystal structure obey the law of rational indices.

We shall now proceed to comment upon each of these postulates in turn, offering some sort of justification for each of them and pointing out their interrelations. The first postulate contains the kernel of the proposed new concept of crystal structure. Various considerations may be urged in favour of its acceptance. In the first place, it removes all uncertainty or arbitrariness in the specification of crystal structure, and has thus a purely philosophical or *a priori* justification. Secondly, it may be remarked that for a variety of atoms of different kinds to settle down to form the regular arrangement in space which we call a crystal, it is clearly necessary that they should all take up places in a common plan and the simplest assumption which we could make regarding the nature of this plan is that it is a three-dimensional network or space-lattice, the points of which provide locations for all the atoms. It is also evident that the existence of such a plan does not necessitate that all the points in the lattice should be filled. *Per contra*, the existence of unfilled places would, in general, be necessary if atoms of different kinds and, therefore, of different sizes are all to be accommodated in the same lattice.

Our second postulate scarcely needs detailed justification. The atomic interactions would obviously determine the manner in which the atoms would take up positions in the postulated common space-lattice, and unless these interactions are of such a nature that they result in specific types of grouping of atoms of the same kind or different kinds about each other, anything like the regular order characteristic of a crystal would clearly be impossible.

Our third postulate may be regarded as consequential on the first two. If we postulate definite types of grouping of the atoms about each other in a common space-lattice, the final result of such grouping should exhibit the various types of symmetry shown to be possible by the theory of space-groups. In the first place, the structure would repeat itself in three dimensions at regular intervals, which are integral multiples of the spacing of the primitive lattice. In other words, the resulting structure would be such that the atomic co-ordinates in the unit of the structure would all be integral multiples of the spacing of the primitive common lattice, and, therefore, either rational sub-multiples or rational fractions of the dimensions of the structural unit. Thus, our postulates would lead naturally to the appearance in all cases of a translational symmetry in the structure of the crystal and also in appropriate special cases, to the types of symmetry recognised in the space-group theory as arising from glide-plane reflexions or screw-axes. But the existence of rational relationships between the atomic co-ordinates and the dimensions of the structural units is a general consequence of our postulates and is not restricted to such special cases.

Our fourth postulate is not an independent one but is merely consequential on our first and second postulates. But it appeared worthwhile to put it forward as a distinct postulate because of its obvious importance in relation to the views of crystal structure here considered, and also because it appears possible to find an independent justification for it. The idea of a directed valence is a fundamental notion of chemistry and is stressed in organic chemistry with reference to the so-called "tetrahedral" valence directions of the carbon and silicon atoms. But one has only to recall cases like cyclo-propane or cyclo-butane to stress the fact that even in saturated carbon compounds, the valences of carbon are not necessarily tetrahedral and that their directions are influenced by the structure. Thus, if the notion of valency has any meaning at all in relation to the crystalline state of matter, we may expect to find the directions in which it is exerted, in other words, the directions of the lines joining neighbouring atoms to bear some simple and specific relations to the structure of the crystal. If such relationships exist, their nature should be of the law of rational indices which one naturally regards as the most fundamental fact of crystal architecture. Thus, if our fourth postulate is regarded as having an

independent theoretical justification, our first postulate would be a consequence of it, and *vice versa*.

Lest it be thought that our present approach to the theory of crystal structure is hypothetical and speculative, it may be pointed out that a great many inorganic crystals, both of an elementary and of a compound nature, whose structures have been determined with some assurance of finality may be described in terms of our present concepts. Indeed, all crystals in which the atomic co-ordinates have been found to be simply related to the lattice spacings, either as a rational sub-multiple or as a rational fraction thereof fall naturally into the present scheme of thought. Many such structures may be found on an examination of the tabulated results of X-ray analysis. Particularly significant are those cases in which atomic locations of this kind are not demanded by the results of space-group theory.

Some Outstanding Questions

Before concluding, it may be worthwhile to reply briefly to some criticisms which may be urged against the present point of view. The most likely criticism that might be urged is that there are apparently well-attested cases of crystals in which the atomic co-ordinates are *not* expressible as rational sub-multiples or rational fractions of the structural cell-dimensions. The answer to this criticism is that such cases deserve careful re-examination with regard to the facts or their interpretation. The atomic co-ordinates here considered are the positions of the atomic nucleii, while the co-ordinates determined from the study of X-ray reflexion-intensity represent the optical centres of the electronic clouds surrounding the nucleii. If the electronic clouds are not spherically symmetrical, the locations determined from the X-ray intensities would not necessarily be those of the atomic nucleii. Another possible source of error in the X-ray studies is the thermal agitation of the atoms which may be considerable and not necessarily symmetrical about the nuclear positions. Not until these and other possible sources of error in the X-ray studies are carefully considered and eliminated in various simple cases which appear to conflict with the present point of view could their evidence be considered to outweigh the significance of the large number of cases in which it does fit with the facts and offers an intelligible explanation of them.

C. V. Raman.

AN INSTITUTE OF SCIENTIFIC INFORMATION FOR BRITAIN

On 8th July a discussion on "The Dissemination of Scientific Information to the General Public" was held at the Royal Institution, London, under the auspices of the Royal Society's Empire Scientific Conference and the British Association for the Advancement of Science. Sir Richard Gregory, F.R.S., who was for many years Editor of *Nature*, was in the Chair, and papers were read by Sir Henry Dale, O.M., F.R.S., late President of the Royal Society, Mr. Ritchie Calder of the *News Chronicle*, representing the profession of journalism, Dr. O. Howarth of the British Association for the Advancement of Science, Commander Ian Cox of the B.B.C., and Mr. Paul Rotha, representing the film industry.

The media by means of which scientific information is disseminated to the general public were reviewed and it was stressed how greatly the war has stimulated a public interest in science—an interest philosophically optimistic and largely vocational. But the specialization of science and the complexity of its organization are baffling to the public, while scientists have a caution and conservatism about publicity.

In view of these considerations the need is apparent for a link between the public and the man of science. It was suggested that this link should take the form of an Institute of Scientific Information, the function of which would be:—

(*a*) To keep a record of all scientific research in Great Britain, in the Commonwealth and in the world as a whole.

(*b*) To obtain access to scientists in order to secure the latest information for issue to the Press or B.B.C. and to refer to the proper scientific authority any story the Press or B.B.C. might bring forward.

(*c*) To supply to the Press and other media lists of learned and technical points in pure and applied science.

(*d*) To keep the Press and B.B.C. supplied with official scientific releases.

(*e*) To give advice and make recommendations on all matters connected with the publicity of science. The producers of films or broadcasts and the organizers of exhibitions or museums would look to the Institute to help them with advice and co-operation.

It was suggested that the Institute would be endowed partly from public and partly from independent sources. It would be called upon to issue pronouncements on controversial subjects and would be judged by the sincerity with which it reacted to varying interpretations of the social function of science.

—*Courtesy of "Monthly Science News"*, 1946, No. 9, p. 60.

OBITUARY

PANDIT MADAN MOHAN MALVIYA

MALVIAJI'S passing away on November 12, at the ripe old age of 85 amid unprecedented scenes of an almost worshipful homage in which over a hundred thousand joined, dropped the curtain over a long and remarkable career consecrated to the Nation's service. Born in a pious Brahmin family with no advantage to start, Malviyaji began life as a teacher with a very early foreshadowing of his gifts for a sustained and inspiring utterance in any cause with a constructive and humanitarian appeal; then a distinguished journalist and leading figure, first in the U.P. (1902-12), and in the Imperial Legislature, Delhi, until 1920; a legal luminary, giving up a lucrative practice for 'whole time' public work; an almost single-handed leader in the campaign to secure for the *Nagari* character its rightful status; Founder-President of the All-India Hindu *Mahasabha*, the *Seva Samiti* and a whole group of organisations designed to harness forces of an awakened religion for the country's service along political, social, cultural and economic channels; called four times to the Presidency of the Indian National Congress, in a way the very greatest gift in the hands of his people, Malviyaji will rank high amongst the illustrious builders of the Indian Nation.

The rich tributes paid by first rank leaders in diverse fields, especially the political, in this country and (some) outside, make it unnecessary to appraise here the latter, the most dominating aspect of Malviyaji's life-work. Ever steeped in the idealism and traditions of the Indian past and an unshakable faith in the greatness of its future, Malviyaji was not unaware of the chief weaknesses of the national position due, *e.g.*, to certain social evils and the extreme backwardness of the economic development. Characteristically enough, he strove to combat the former rather by mass appeal to reason and social conscience, than through legislation; for the latter, he appealed for popular enterprise and initiative and a broad-based State policy. His work on the Industrial Commission (1916-18) and his famous minute of dissent to its Report reveal markedly Malviyaji's ever-active spirit of constructive criticism and realistic outlook.

While any of these lines of work would have sufficed for "a life's reputation", Malviyaji's claim for a permanent place in the recollection of his country is his monumental work as the Founder, for twenty-one years the Vice-Chancellor, and last seven years the Rector (in the late Dr. Besant's words, "the very heart and soul") of the Benares Hindu University, spread over a campus of 1,300 acres, and adjacent to the holy *Kashi* of immemorial and hoary traditions; this was the first teaching and the residential University in the country, with Rs. 105 lakhs collected from Princes and public—a unique tribute to Malviyaji's indomitable will and the people's trust. The University was "established to preserve and popularise all that was good and great in the ancient civilisation of India and, at the same time, to impart instruction along lines of the best of modern Universities". Here, more than anywhere else in the motherland, will abide for ever in imperishable memory, the spirit of this *Rishi* and a maker of modern India.

S. S. JOSHI.

SIR JAMES HOPWOOD JEANS, O.M.

IT is with deep regret that we record the death, on 16th September, of SIR JAMES HOPWOOD JEANS, O.M., F.R.S., at the age of 69. Jeans was known throughout the world not only for his many original contributions to mathematical physics but also for his lucid expositions of science in books and articles intended for the general public. His academic career was a brilliant one, and among the positions he successively held were those of Professor of Applied Mathematics at Princeton (1905-9), Stokes Lecturer in Applied Mathematics at Cambridge (1910-12), and Professor of Astronomy in the Royal Institution. He held also many important offices and was at various times Secretary of the Royal Society (1919-29), President of the Royal Astronomical Society (1925-27), and President of the British Association for the Advancement of Science (1934). He was honoured by universities and societies throughout the world, and received among other awards, the Royal Medal of the Royal Society, the Gold Medal of the Royal Astronomical Society, and the Franklin Medal of the Franklin Institute.

One of Jeans' first major contributions to science was his confirmation of Lord Rayleigh's law for black-body radiation. In this field he quickly recognized the significance of Planck's quantum theory and used it skilfully to develop his own theories. He gave too, in 1903, the first rigorous proof of Maxwell's law for the distribution of velocities among the molecules of a gas. Although his work materially advanced many branches of physics, Jeans is most generally known for his cosmogonic work. His brilliant theories of the origins of the planets and their satellites and of the source of stellar radiation have gained wide, if not universal, acceptance. He will be remembered too for his philosophical interpretation of modern science. Though his philosophical theories have excited much controversy, they represent a courageous and carefully considered attempt to answer problems whose manifest difficulties have deterred most of his contemporaries. His death is a severe loss to British science, the more so as it comes at a time when the rapid advancement of science is creating so many urgent philosophical problems.

—(*Courtesy of "Endeavour"*, Oct. 1946, p. 154.)

PROBLEMS OF THE INDIAN COAL INDUSTRY*

ONE of the many striking paradoxes for which India is famous is her coal position. India produces over 30 million tons of coal per year and is the second largest producer of coal in the British Commonwealth. Yet, our industrial development has not progressed beyond one-twentieth of our capacity. We have extensive deposits of coal, but we have hardly touched even the outermost fringes of the numerous industries that are based on coal and its products, and that are essential for our national welfare and progress. We have only to look at the latest advances made in the field of coal industry in other countries to convince ourselves of the utter neglect we have meted out to this important mineral, which in its importance may be compared to food. Coal is as much a food for the maintenance of industrial life as food is the fuel for the sustenance of human life.

For efficient utilisation and conservation of coal, all progressive countries have adequate provision both for research and development. In England, the coal situation is so serious that the whole industry has been under critical examination. Particular attention has been directed to explore the possibilities of mechanisation of the mining methods. This is expected to give not only longer lease of life to the mines but it will surely lead to the quickening of the pace of production and to the amelioration of the social conditions of coal miners. The U.S.A. has now the lead in this direction, although it is admitted that the first mechanical devices were employed in Great Britain. They were abandoned because research work in England in the subject of Engineering did not keep pace with the rapid utilisation of coal for industrial purposes. The arguments that the British coal seams were not amenable to treatment by mechanical methods of an automatic character seem to be based on prejudice and recent American attempts to provide automatic mining methods in England seem to have been on the whole a success. It is not hard to imagine how much of the arduous and unpleasant labour could be saved in this country if only efforts are made to introduce mechanisation in the mining of coal in India. As labour is still available in India comparatively cheaper, it may not be considered as vitally important as yet, but we must look ahead and provide for mechanisation.

Perhaps a few words on the achievements of coal research may not be out of place on this occasion. Research investigations on the preparation, transportation and storage have yielded results of great importance to the coal industry. It has involved scientific work on sizing and grading, briquetting, coal breakage, wet washing, dry cleaning and gravity washing under dense media and such subjects as control of fires, dewatering and drying, dustproofing, coal storage and physical structure of coals.

The Regional Coke Research Committee in Great Britain have mainly addressed themselves to research investigations leading to increasing the flexibility of the coking process with a view to using inferior coals for the purpose of conserving the high grade coal resources and to controlling the products according to demand. This has led to several new processes such as the carbonisation of various single and blended coals and to the modification of the carbonisation plant itself. Mention must be made here specially of the plant known as the Narrow Brick Retort. Considerable investigations have been carried out in the U.K. on the chemical conversion of coal, tar and coal products. Of these, gasification, the hydrogenation and cracking of tars and oils and the Fischer-Tropsch Process for the production of synthetic petroleum are of special importance. The wide range of investigations covered by the various Fuel Research Laboratories include geological, physical and chemical survey of coal seams, coal cleaning and preparation of coal for the market; low and high temperature carbonisation; complete gasification of coal; production of hydrogen from coal and coke; and fundamental research comprising of solvent extraction, coalification, petrographical classification, study of porosity and surface, particle size determinations, X-ray diffraction, radiography, reflectivity, assays, thermal distillations, chromatographic separation, spectroscopic examination, etc.

The Coal Division of the Bureau of Mines in U.S.A. has been responsible for comprehensive investigations on coal in all its aspects from production to utilisation. Perhaps, the most notable achievements of America in this field are the oxidation products of coal. Numerous organic acids have been obtained by the oxidation of coal which are finding increasing importance in plastics, dyes and drugs industries. Mention must be made also of researches which have enabled producer-gas manufacture from inferior coals, development of smokeless burners for residential buildings, new coal-fired steam locomotives to compete with diesel locomotives, pulverised and colloidal fuels, complete gasification of coal, etc. In the coking industry perhaps the most outstanding work is that of Messrs. Koppers Company of New Jersey. They have introduced such features in their plant for producing coke which makes the once old hot and uncomfortable process, now a thing of joy. All the operations are automatically carried out in an air-conditioned basement; and with the aid of just a few men, large quantities of coke are produced from coal and the bye-products also are automatically collected. Intensely original and fascinating are the Russian investigations on underground gasification of coal. From the point of view of saving initial costs and the economic production of gas these investigations have attracted world-wide attention and the very idea underlying underground gasification, which makes use of the earth itself as a huge retort, which is heated by the fire that is produced gratis inside its bowels, is indeed revolutionary. It is not necessary for me to stress the significance of this development to this country where underground destruction of coal

* Extracts from the Opening Address delivered by Prof. Sir Shanti Swarup Bhatnagar, Director, Scientific and Industrial Research, on the occasion of the Foundation-Stone Laying Ceremony of the Fuel Research Institute, Digwadih—Dhanbad, on 17th November 1946.

by spontaneous fires has already resulted in colossal losses.

It has been estimated that the life of the reserves of Indian coals are as follows: All good quality coals—120 years; coking coal of good quality—about 62 years; non-coking coal of good quality—about 100 years. It will be seen that the position of the coking coal reserves in India is poor, especially in view of the fact that very large reserves of 'iron ore' of high grade are available in the country. Within 150 miles of the coalfields alone the iron ore reserves exceed 3,000 million tons. It is obvious that our reserves of coal are short of our needs. At the present rate of output and consumption and at the present rate of mining, the reserves in India can hardly last more than fifty years unless more efficient utilisation and conservation of the coking coals are practised.

Next in importanse are all grades of coal of high volatile content and of the non-metallurgical type. These coals, apart from steam generation, have very special uses, such as carbonisation, bye-products recovery, hydrogenation or synthetic production of oils, gas manufacture, chemical industry and so on. The coal-tar distillation industry, sadly neglected in the past, is an absolute necessity to-day. The great varieties of oils, high explosives, dyes, drugs and pharmaceuticals, plastics, insecticides, germicides, rubber, etc., which can be derived from coal-tar, are all essential for national progress and well-being. Great losses are also resulting from the primitive methods of soft coke or domestic coke manufacture and research must help in solving this problem.

Another source of loss of coal is during the mining operations. During mining a part of the coal is small or "slack" coal and as such it has no market in India. Utilisation of this coal with the help of modern scientific and technical methods of combustion and briquetting would avert this great waste. Many of the so-called inferior grades of coal of high ash content, of which India possesses a large and 'fairly unlimited' reserves are also not workable at present. These coals can be upgraded and efficiently utilised through research and development of appliances.

An important feature of our coal industry is the lack of any standards for specifications. It is not generally recognised that this lack of standards results in wasteful mining methods and in consequent loss of large reserves of coal. The present methods of certifying coals on the basis of the specifications of the Indian Coal Grading Board has often led to selective mining of seams resulting in serious loss of coal. Stowing and utilisation of the inferior qualities of coal are the only measures to check these wasteful methods of mining resulting in the loss of our irreparable national asset.

The 'by-products' industry, which is still in a primitive state in India, must also be developed for the future prosperity of the fuel industry and the nation. All these can only be achieved through co-ordinated and intensive scientific research. The first notable step taken in this direction was the constitution of a Fuel Research Committee in 1940 under the auspices of the Board of Scientific and Industrial Research with the late Dr. H. K. Sen as Chairman. Sir Cyril Fox and Mr. Farquhar succeeded Dr. Sen as Chairman. During these six years the Fuel Research Committee has been responsible for initiating several research schemes bearing on Indian coal industry, the most important of which are the washability of Indian coals under the guidance of Dr. Charles Forrester of the Indian School of Mines; the coking and blending of coals under the joint auspices of Mr. Farquhar of the Tata Iron and Steel Co. and the Council; and the carbonisation and desulfurisation of Indian coals under the guidance of Dr. B. C. Guha and Dr. J. K. Chowdhury respectively. The most important activity of this Committee has, however, been its concerted effort to bring about a central Fuel Research Station for India which will carry out comprehensive research on all aspects of fuels. The Council of Scientific and Industrial Research accepted the recommendations of the Fuel Research Committee in respect of the urgent need for a National Fuel Research Institute and appointed a local planning committee to draw up detailed plans for the proposed Institute. Of this committee, the leading lights are all present here. Our special thanks are due to Mr. Kirby, Chairman of the Local Planning Committee, Dewan Bahadur Thacker, acting Chairman of the Fuel Research Committee, and Dr. Charles Forrester, Principal, Indian School of Mines. We miss Mr. Farquhar and Mr. Wilson-Haigh, who are on leave, and who contributed much towards the success of our earlier efforts. The Fuel Research Committee also appointed a Site Selection Committee, who after much careful thought and deliberation, chose the present site. Here the superior rights of about 100 acres of land were very generously donated to the Council by the Raja Shiva Prasad Singh Bahadur of Jharia for the construction of the Fuel Research Institute.

The Fuel Research Institute of India when completed will cover all aspects of research both fundamental and applied, on solid, liquid and gaseous fuels, although for the present the activities of the Institute must necessarily be confined to a large extent to solid fuels and coal in particular. The work has been divided into a short-term programme and a long-term programme, and this arrangement is only in accordance with the urgent and future needs of the country in respect of fuels.

The short-term programme includes:

(1) *Rip Survey.*—A quick physical and chemical survey of Indian coals with a definite time limit, say two to three years, involving the determination of proximate analysis, coking properties, total sulfur, calorific value, carbon and hydrogen contents and washability of the major producing coal seams.

(2) *Washability Tests.*—These tests will be carried out on full-scale samples from seams with a view to improving ash contents of coals of coking quality and for separating coking from non-coking coal in the same seams.

(3) *The Coking and Blending of Coals.*—Laboratory, medium and full-scale tests (in co-operation with the industry) on some selected coal seams with a view to immediate exploitation and examination of the reactivity of coke.

(4) *Low Temperature Carbonisation.*—Laboratory investigation for survey and

full-scale tests on some selected seams, again with a view of immediate exploitation and selection of some plants which have already proved successful on an industrial scale.

(5) *Gasification.*—Investigation of alternative supply of fuel for the immediate manufacture of hydrogen for ammonia synthesis and for complete gasification of inferior grade non-coking coals for the manufacture of industrial gases. This is a subject of great interest and has been rather neglected in India.

(6) *Investigations on Road Tar.*—In view of the post-war road building programme in India, this research will be undertaken early.

The long-term programme will include :—

(1) Detailed survey of Indian coals for the determination of all the physical and chemical properties of coals, including agglutinating value, swelling properties, washability, calorific value ; and development of specification tests.
(2) Investigations on carbonisation and coking properties.
(3) Deterioration of coal on storage and weathering.
(4) Researches on de-ashing and preparation of coal for the market.
(5) Researches on the nature of by-products of low and high temperature carbonisation with a view of their utilisation for the plastics, dyestuffs, drugs and pharmaceuticals, liquid fuels, lubricants and grease industries.
(6) Briquetting.
(8) Hydrogenation.
(9) Oxidation of coal for the production of dyes, plastics and allied substances.
(10) Liquid, gaseous and wood fuels.
(11) Establishment of a Central Fuel Research Library.
(12) Fundamental Research in Fuels.

All these proposed investigations stress the importance of coal as fuel and as a valuable source of chemicals for industry. I must, however, assure you all that the National Fuel Research Institute will not confine its activities to research on coal only. In fact, investigations on other fuels, such as for instance, mineral oils, gaseous fuels, colloidal fuels, etc., will form an important part of the functions of the Institute. In this connection, I would like to mention the importance of molasses-alcohol, which is a basic industry of India and which has great potentialities as an industrial fuel. The present estimated production of alcohol in India is in the neighbourhood of 22 million gallons, and during the war, when petrol was in acute short-supply, molasses alcohol retrieved the position and it was successfully used as fuel in internal combustion engines in admixture with petrol. Investigations bearing on these aspects of all fuels besides coal, will certainly engage the attention of the Fuel Research Institute.

Research alone will not solve all our problems. State measures to control and conserve production and utilisation of coal on lines likely to promote the interests of the industry are equally important. The necessity of such measures was realised sufficiently long ago, and the Government set up Inquiry Committees twice in the last decade. These committees had formulated many far-reaching recommendations but the indifference of the authorities cold-storaged the recommendations. Many of our problems would, by now, have been minimised if only the people who held authority then had the foresight to see the immensity of the problems and had acted on the recommendations. During the war, the problems assumed alarming proportions, and Sir Ardeshir Dalal on taking over the Planning and Development portfolio appointed the now well-known Indian Coalfields Committee under the chairmanship of Mr. K. C. Mahindra to review in detail the Indian coal position and to suggest ways and means of improving the coal industry. The Mahindra Committee have now submitted a useful report. They have brought out the importance of nationalisation of the coal industry in India and of setting up a separate Department of Fuel and Power and also of a National Fuel Board vested with powers to control production, distribution and utilisation of coal in India. The Committee have also stressed the importance of technical research on coal and have recommended the setting up of three Research Sub-Stations in the Raniganj, Bokaro and C.P. coalfields, in addition to the Central Research Institute. Another important recommendation of this Committee is that the cost of fuel research should be shared by Government and Industry and a cess of one pice per ton of coal despatched should be levied for this purpose. Similar recommendations were made earlier by the Council of Scientific and Industrial Research and the Sir Shanmukham Chetty Committee.

SOLAR SPECTRUM LINE INTENSITIES

DR. M. MINNAERT, of Utrecht, Holland, temporarily at Yerkes Observatory, described work now going on to compile a catalogue of the intensities of the Fraunhofer lines in the solar spectrum. Just before the war, the Utrecht Observatory published the *Photometric Atlas of the Solar Spectrum*, giving a graphic record of the intensity distribution in all the Fraunhofer lines. The new catalogue, compiled from the atlas, is already complete for the red and infra-red regions.

—(*Courtesy of "Sky and Telescope,"* No. 61, *November* 1946, p. 7.)

DEVELOPMENT OF SCIENTIFIC MAN-POWER AND MATERIAL RESOURCES*

I HAD occasion to visit the scientific and technical institutions of the United Kingdom last summer; and I was impressed by the strenuous attempts that were being made there to develop the scientific man-power and resources to the limit of capacity. It is universally recognised that no expenditure of public funds can be too high which aims at training men of science in sufficient numbers for successful execution of the post-war plans of reconstruction. The United Kingdom has at its disposal to-day a force of 55,000 qualified scientists (scientists include technologists); it is estimated that the demand for scientists by 1955 will not be less than 90,000. Hence the universities are being pressed to undertake an expansion of the order of 80 per cent. within the first post-war decade. Besides, the existing university colleges at Nottingham, Southampton, Exeter, Hull and Leicester, are being helped to expand rapidly and earn full university status at an early date.

In India, I wish a similar guidance were given us by competent planning authorities regarding our need for trained scientific and technical personnel within the first post-war decade. Training in Science and Technology costs far more than training in humanities and liberal arts. Whatever may be the policy in advanced countries like England, a poor country like India cannot afford to dissipate her resources for training technical personnel for whom gainful employment is not ready at the end of the training. The Government of India have now in their possession a large number of reports on planned development of various industries which have been prepared by the technical panels of the defunct Planning Department. I also understand that the Departments of Communications, Power and Mines have prepared accurate surveys of our present position regarding power, fuel, transport and irrigation. They have also made tentative suggestions perhaps too modest in their scope, regarding targets of development of these resources which may be attained in the course of five years. Governments, everywhere, in periods of transition, have to shoulder responsibilities and bear burdens which appear almost too heavy. It is a good sign of the times, that in spite of the sombre picture which is now blocking their vision, there is a general realisation among our leaders of the fact that the great issues on which our national future depends are at least as much economic as political: and we welcome the appointment of a Planning Advisory Board by the Central Government which will digest the valuable material which have been already collected and recommend at an early date to Government concrete projects for execution as integral parts of a well-planned developmental programme. I hope that the Planning Advisory Board will examine carefully the question of resource development in relation to availability of technical personnel, and give us the country's probable requirement of such man-power in the course of next ten years. I feel that we may also render Government a timely aid at this juncture. It may not be difficult, if all the members of our Association take up the work seriously to make a complete survey of the technical personnel that already exist in the country. Such a survey may give useful information regarding the wastage of such man-power, and also a factual appreciation of their efficiency in the creation of national wealth.

Capitalism *vs.* Technocracy

The National Planning Committee recommended long ago that in a free democratic India, the Defence industries, the key industries and the public utilities must be owned, (or in exceptional cases controlled), by the State. It is probable that all planning for resource development will be shaped by this ideal. State ownership inevitably means management of an industry or a utility by technicians who have proved their capacity for business administration. In India owner-capitalists have up-till now formed the *core of business management*. But even in countries which have retained their capitalistic economic structure, James Burnham has brought out fairly convincing arguments to show, that capitalism is rapidly changing into a managerial society. The administration of the many limited liability concerns in India are even now really vested in managing agents. It is necessary, therefore, that Technical Colleges should include provision for management studies, so that technical men who aspire to positions of senior administrators and engineer-managers may acquire early in their career all available knowledge relating to industrial organisation and efficiency audit.

The Human Angle

But this is not enough. All planning centres round the idea of human betterment and increase in human happiness. We hope that under the dynamic leadership of a National Government, human nature in India itself would enter upon a new phase of development. The placid pathetic contentment of a helpless and ignorant people, resigned to the vagaries of Fate, will be replaced by a vigorous and willing co-operative effort, which will harness modern knowledge and technology, and create a social and economic structure intended to give to every citizen a fuller and more satisfying life. The technician in India will have to realise that his mechanical efficiency will be of little avail in developing such a satisfying life, if the industrial world which employs his skill is governed with little wisdom. He should be imbued from early years with principles of social justice which rest on moral conceptions of human behaviour, so that when he attains positions of administrative responsibility, the happiness of men working

* Excerpts from the Presidential Address delivered by Sir J. C. Ghosh, Director, Indian Institute of Science, to the Association of Principals of Technical Institutions (India), at Delhi, on Thursday, 21st November 1946.

with him becomes as weighty a consideration as the efficiency of the organisation which he is handling. He should remember that willing work in a congenial atmosphere elevates the stature of man; and that unwilling work extracted from a man tied to a machine is really a form of slave-driving. His education should open a window in his mind through which he can see visions of what science allied to morality can do for the human race.

I, therefore, cannot too strongly recommend for inclusion in the curriculum of higher technological education, those branches of humanities which will make the technologist a better citizen and a better administrator.

In conclusion, may I suggest that sometimes in their leisure hours, men of science and technology in India ponder over the following significant observation of the Dean of Canterbury, and cogitate how Indian masses can be galvanised into similar life:—"The strength of Soviet Russia which confounded the Fascist armies and astounded the world, the reason which made such miracle possible, springs from a twin source—the one moral and the other scientific. These two are really one. Science is based on truth of things and forces. Morality is based on truth underlying human beings and their actions. Russia's secret weapon is the weapon of science applied not for the profit of the few but for the well-being of all. Her second secret weapon is the courage and limitless endurance of people who knew that they were defending with their lives, the new way of life which they had built."

CONSERVATION AND CONTROL OF WATER AND WATERWAYS*

INDIA is fortunate in her immense resources in water and in her widespread waterways. But at present, the bulk of this water runs in uncontrolled floods doing damage to life and property. The waterways, which should, if properly trained and regulated, afford extensive arteries of traffic for the very cheap transport of agricultural and industrial produce, are lying mostly neglected with the result that during certain times of the year they form isolated pockets of stagnating water favourable for the breeding of mosquitoes. Without the application of water on lands, where rainfall is short or unseasonable, there can be no further increase in the area under cultivation or in the crop yield. Without assured and regulated supplies of water, there can be no source of cheap power and, therefore, little prospect of the exploitation of our mineral wealth and industrial development on any considerable scale. Without a network of waterways available for inland navigation, the bulk of rural areas will remain cut off from the markets and centres of industries and other developments.

Water and waterways are, therefore, the basic sources of wealth and national well-being. The projects for the control and conservation of water for purposes of flood control, irrigation, navigation and power generation, will not only help in protecting the countryside from flood damage, in growing more food, in generating cheap electricity for industrial, agricultural and domestic uses, and in affording cheap means of transport of goods, but will also bring in substantial revenues to the State in the form of returns from irrigation, power and navigation, and in taxes and otherwise, which after paying the interest on capital charge and maintenance and operation expenses, will leave ample surpluses for utilisation on other nation-building activities such as education, public health, defence, etc.

But the productivity of a project for the harnessing of the water resources of a country should not be measured merely in terms of the direct revenues and net returns, but in terms of the resulting rise in standard of living of the people affected by that project, of the general increase in their wealth and well-being and in the resulting indirect returns to the State. The indirect benefits of such projects to the people and the State are indeed great. They would afford work on a mass-scale during construction and subsequent maintenance and operation. They would afford ever-increasing opportunities for work in the expansion of agriculture and in the new industries that will spring up as a result of the raw materials and cheap power made available by the project.

The large reservoirs formed for the storage of water will afford immense possibilities for fish culture and thus provide the much-needed protective foods for the masses.

The control, conservation and regulation of water for beneficial use, must, therefore, be our first concern in any scheme of national planning. The extent to which we can control and conserve our water resources will determine the extent of our national security, national well-being and national wealth. It will determine the standard of living of the common man.

Water Wealth of Rivers

On a rough calculation, the mean annual supply of water in our rivers appears to be of the order of 2·3 million cft. per second. Most of this supply is, however, concentrated in the monsoon months and except for the snow-fed rivers coming from the Himalayas, the bulk of the rivers run almost dry during the dry months. The mean annual consumption of water for agricultural purposes derived from the canals has been roughly figured out as 133,000 cft. per second. Possibly another 30,000 cft. per second is utilised for irrigation from wells. This means that less than 6 per cent. of the available water wealth in our rivers is being utilised and the balance of over 94 per cent. is running to waste in the sea and in the process doing incalculable damage to life and property through uncontrolled floods and

* Extracts from the Presidential Address delivered by Rai Bahadur A. N. Khosla, I.S.E., Consulting Engineer with the Government of India and Chairman, Central Waterways, Irrigation and Navigation Commission, at the Seventeenth Annual Meeting of the Central Board of Irrigation, held on the 26th November 1946.

their aftermath of blocked drainages, stagnating pools and malaria mosquitoes. It is difficult to say offhand what proportion of this 94% of our available water wealth, which is at present running to waste, can be put to beneficial use; but there is no gainsaying the fact that a very substantial portion of it can be so utilised. If the utilisable, but so far unused, water potential is no more than one-third of the total, it will amount to five times the total quantity of water which is being used at present throughout the country. That is an indication of the immense scope for extension of irrigation and power development and of the vast magnitude of our problems and opportunities.

India's Acreage

The total area of India is just over 1,000 million acres, about half of which lies in Indian States. A little over a third of this is covered by forests, roads, railways, towns, factories, etc., and is, therefore, not available for cultivation. Of the remainder, about 400 million acres are generally under cultivation but over 250 million acres, either lie fallow or are uncultivated wastelands. The principal reason for such a large area lying undeveloped is no doubt the lack of irrigation facilities and in a number of cases the liability to floods. Of the 400 million acres which are now under cultivation, a substantial part gets but indifferent crops for lack of assured water supply. As an illustration of the increase in the out-turn of crops that results from irrigation, statistics show that in the U.P., Madras and the Punjab the out-turn of rice from irrigated areas is better by 30 per cent., 40 per cent. and 60 per cent. respectively than from unirrigated areas. Similar figures for wheat are 50 per cent. in Sind and U.P., 60 per cent. in the Punjab and N.W.F.P., and 150 per cent. in Bombay.

India has each year 70 million acres under irrigation from canals, tanks, wells, etc. This is the highest irrigated acreage in the world. Without this extensive irrigation vast areas, particularly in the Punjab and Sind where rainfall is between 4" and 15", would have remained barren wastes and no crops could grow with that scanty and uncertain rainfall. Our canals have a carrying capacity of about 400,000 cft. per second. The number of wells in the country runs into hundreds of thousands; but with all these spectacular figures, which have no parallel in the world, we are still a deficit area so far as food production is concerned.

Development of Cheap Hydro-Electric Power

Our schemes of irrigation in the past, particularly in North India, were mainly confined to the diversion of available supplies in the river and were relatively cheap. Such supplies have, however, been almost entirely used up. Henceforth, our main hope of extension in irrigation will lie in the surplus supplies which can be stored during the monsoon months and released as required during the months of short supplies. Such irrigation projects may not be fully self-supporting if confined in their use to the single purpose of irrigation. But fortunately such projects lend themselves to multi-purpose development. The storage of supplies during floods will lead to flood control. The equalisation of supplies during the year by means of storage will make available considerably increased supplies throughout the year which can be utilised for increased perennial irrigation and for the development of cheap and perennial hydro-electric power.

Cheap power is our greatest need at the moment. It is needed for domestic purposes. It is needed for the manufacture of fertilisers and for agriculture. It is needed for industry. It is needed further to conserve our limited resources in high grade, particularly metallurgical coal, vast quantities of which are at present being used up in generating power for industry, locomotive power for railways and as domestic fuel—a great national waste considering how vital coal is to our industrial economy and national defence. Coal as a means of generating power is exhaustible. Water, or so-called white coal, is inexhaustible. Its use for power generation involves no drain on our natural resources and would release coal for use for other purposes of national importance.

Electricity will constitute a most important item of amenity in the life of our backward and neglected rural population. With electric light in the house, a farmer can use his spare time in reading and improving his mental equipment. With cheap electrical heating he can save cowdung for use as manure. He can save fuel-wood and thus help in conserving our forest wealth for more profitable and long-range exploitation. With cheap hydro-electric power he can set up small cottage industries which will bring him additional income and provide him occupation during the long periods of enforced idleness between crops. Our objective should be to carry the benefits of cheap water power on the basis of "service at cost" to every village and to every home somewhat after the model of Canada and Sweden, both of which countries owe their present industrial development, wealth and prosperity to water-power.

It has been said that the *per capita* use of electricity of a people is the measure of their prosperity and power in the economical, social and political spheres. This *per capita* consumption is 9·2 kilowatt hours in India, 906 in England, 1,470 in U.S.A., 3,510 in Canada, 1,944 in Switzerland, 3090 in Norway and 2,000 in Sweden. This is a good indication of our position as compared with some other countries in the world. We have a long way to go before we can catch up with them. But we are fortunate in that India has a very large power potential in her unused water resources. That potential has not been correctly evaluated. It was stated to be less than 5 million k.w. by Meyers in 1920. He based it mainly on the available minimum continuous supplies in the rivers. On a rough approximation, the water-power potential of India is likely to be well over 30 to 40 million kilowatts. Against this our existing water-power development has not yet passed the half million mark. That shows the immensity of the scope for development.

Projects Under Consideration

The few projects now under consideration, namely, the Bhakra and Nangal in the Punjab, Nayar and Rihand in the U.P., Kosi in Nepal, Damodar in Bihar, Tista in Bengal, Mahanadi in Orissa, Machkund, Godavari and Tunga-

bhadra in Madras, will provide power to the extent of about 4 million kilowatts of which the Kosi Project alone may account for a million and a half. The power production and power potential of India in the world context is somewhat as follows :—

	Population million	Water power potential million	Water power developed K.W.	Developed as % age potential	Per capita consumption of electrical energy all types units
U.S.A.	150·6	48·9	16·8	34	1470
Canada	11·2	29·5	7·1	24	3510
U.S.S.R.	170·5	100·7	22·4	22	?
U.K.	45·0	?	0·22	?	906
France	41·8	8·9	3·7	42	431
Germany	69·6	5·9	3·2	54	1240
Switzerland	4·3	4·5	3·0	67	1944
Sweden	6·5	7·5	2·0	27	1455
Norway	2·8	4·5	2·4	53	3090
India	400·0	30 to 40	0·5	1	9·2
China	500·0	?	?	?	?

I am just back from a visit to Sweden and Canada, the two countries where coal is scarce and whose power development is mainly confined to water-power. In Sweden generation is mainly in the north and load centres in the south. The power is transmitted to distances up to 400 miles at present and will extend to as much as 600 miles in their schemes of the future. Some 87 per cent. of the rural population of Sweden are served by electricity and 35 per cent. of the main railways have been electrified.

The benefits of the schemes of multipurpose development if carried out on a nationwide plan, will extend to all areas and to all inhabitants and should, therefore, be the biggest unifying factor between the various communities in the economic, social and political fields, and the most effective safeguard against fratricidal strifes.

Irrigation Research in U.S.A. and Canada

During my recent visit abroad I was struck by the tremendous expansion in irrigation research activities, particularly in U.S.A. and Canada. The strength of personnel has been almost doubled and large sums of money have been set aside for research. The research laboratories of the U.S.A. Bureau of Reclamation, Denver, are being moved ten miles outside to extensive grounds and newly designed buildings. with facilities for expansion. This expansion has taken place in all branches of research, hydraulic, cements, concrete and earth materials, hydraulic and electrical machinery, mechanical appliances, etc. A triaxial machine—perhaps one of the two or three in the world—has been set up there to make a direct study of the stresses in three dimensions. The research laboratories in Toronto are bringing out new, more efficient, and cheaper utility articles for the common man and producing new and improved designs of hydraulic machinery, construction equipment and better methods of construction. In Sweden researches are underway for high-tension long-distance transmissions upto 400,000 volts A.C. or D.C., but preferably D.C.

Research in India

It is gratifying to note that research activity in India is steadily on the increase. We have the Punjab Irrigation Research Institute, Indian Waterways Experiment Station, Poona, the Bengal River Research Institute, the U.P., Madras and Bombay Research Stations. New Research Stations are being set up in Hyderabad and Mysore. Very soon we shall be making a start with the Central Waterways, Irrigation and Navigation Research Institute at Delhi, which will be comprehensive in its scope and deal with all aspects of the many problems connected with rivers, irrigation, navigation and allied developments.

Research has yielded rich dividends in other countries. I am convinced that with proper direction and co-ordination irrigation research in India will likewise produce results which will play a most useful part in our schemes of development. India leads the world in the science of irrigation engineering and in matters of distribution of water and assessment policies, but it must be recognised that in many fields of activity, particularly machinery and instruments, India has so far been content to live on the inventions and enterprise of others. With our network of research organisations the stage will have been set for India to contribute her share to the world peel of science and inventions.

Training Technical Personnel

At this stage, I would like to draw the attention of Members of the Board and of the administrators responsible for policy, to the acute shortage of technical personnel in the country. The planning, design and construction of the projects for the multipurpose development of our water resources will necessarily be spread over many years, possibly decades. They will be in operation ever after. The researches undertaken in connection with these developments will extend far into the future. To man these projects and researches during various stages, we shall need technical personnel by the hundred. It is most important. therefore, to lay down as early as possible, a definite policy to increase suitably the number of technical colleges in the country and also the output from each. The courses of studies and training to be imparted at these colleges require very careful consideration and planning. It will be necessary in the early stages to send abroad a number of qualified engineers with adequate experience of works in India for specialising in various aspects of our schemes of development. This specialisation should be so arranged that between them a particular batch of engineers may be in a position to handle all problems connected with a project through all stages of development. This training abroad will also need careful planning and precise instructions will have to be laid down for each set of individuals.

INFLUENCE OF THE FORM OF NITROGEN ON THE QUALITY AND OF QUANTITY "PITCH" IN DISTILLERY PRACTICE

By KALYAN KUMAR MITRA and M. SREENIVASAYA

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NITROGEN which is provided in different organic and inorganic forms, constitutes an essential nutrilite for the growth and functioning of yeasts. Although a few disputable claims have been made that yeasts are capable of fixing elementary nitrogen[1,2,3,4] it is generally accepted that the greater and the more substantial part of its nitrogen requirements, have to be met through a supply of assimilable forms of nitrogen which are covered by a wide range of the comparatively simple inorganic and the more complex organic compounds.

Lindner[5] has made a study of the various sources from which an yeast could obtain its requirements of nitrogen. He found that compounds with long hydrocarbon chains were assimilated with comparative ease as compared with the utilisation of ring compounds like histidine. More recently, Nielson[6] and Hartelius,[7] in the course of their comprehensive studies, have investigated the relative efficiency, of some 36 different amino-acids as sources of nitrogen for the growth of yeast; some of them individually and in particular combinations have been shown to exert a growth-promoting effect.

The pioneering studies of Hartelius,[6] Nielson[7] and Thorne,[8,9,10] on the relative value of amino-acids as sources of nitrogen for yeast, have revealed that :—

(1) they vary among themselves in their nutritive value,
(2) the nitrogen in amino-acids is taken up by yeast in the form of ammonia which is formed by decarboxylation,
(3) amino-acids in mixtures exhibit a growth-stimulating efficiency which is far greater than what might be expected if the effect were merely additive,
(4) some of the amino-acids when administered in minute amounts (*e.g.*, β-alanine, asparagine, aspartic acid, glutamic acid, lysine and arginine) are found to possess a stimulatory effect on yeast-growth,
(5) Yeasts differ among themselves with regard to their response to various amino-acids.

The alcohol-producing capacity or attenuative power of an yeast naturally depends upon the concentration of the zymase complex, whose content of the "pitch" would determine its overall efficiency. The elaboration of the zymase complex in yeast is intimately connected with its nitrogen metabolism. Sippel reported that the attenuative power is restored by the addition of soyabean flakes to the extent of 0·2 to 3·0 per cent.; this supplement resulted in a replenishment of the normal protein content of yeast which had decreased by about 10 per cent. Difficulties of attenuation and of harvesting of yeasts have been traced by Bishop and Whitely[11] to the low content of nitrogen in worts especially when strongly attenuating yeasts are employed.

The fall in the attenuating power of "pitches" in distillery practice, is a common occurrence in most of the Indian distilleries. This is mostly due to faulty and poor nutritional conditions under which the "pitch" is built up. One of the essential limiting nutrients is nitrogen. In view of the importance of this nutrilite in distillery practice, we have made a systematic study of the efficiency of different sources of nitrogen on the rate of growth, the extent of growth and the attenuating power of the resulting harvests of yeasts.

Part I. Rate and Extent of Growth

Experimental

In the present investigation seven sources of nitrogen have been tried, ammonium sulphate, urea, asparagine, wheat bran extract, proteolysed extracts of groundnut cake and the distillery

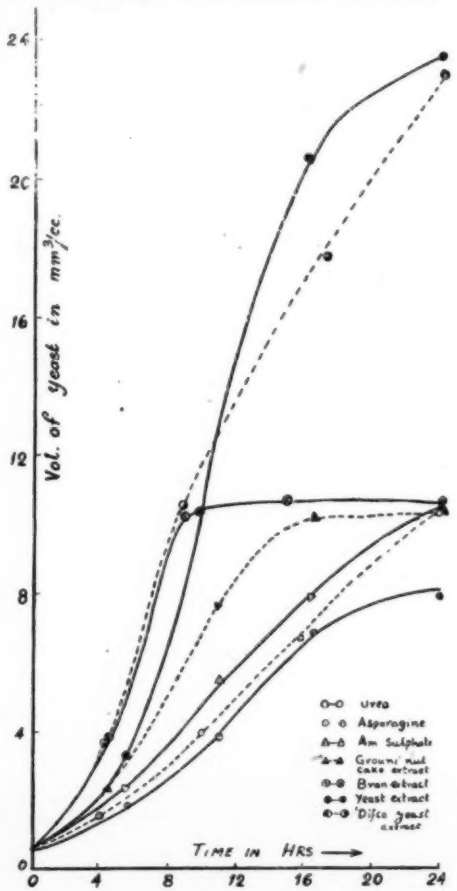

Fig. 1

yeast residues and "Difco" yeast extract. The basal medium employed in the course of these studies was similar in composition to the one used by de Scuza and Sreenivasaya.[12] The organism investigated was a strain of distillery yeast developed in the section of Fermentation Technology, and the one which has proved eminently successful in yielding high concentration distillery washes. The nutrient solution was supplemented with different nitrogenous extracts to the extent of 44 milligrams per 100 ml. of the medium. The yeasts were grown in tubes bent at an angle of 45° and mounted on a shaking machine specially constructed for the purpose. The tubes were shaken 80-90 times per minute thus securing efficient aeration of the reaction medium and the cultures were allowed to grow for 24 hours. At intervals, growth of this yeast in the medium was measured by centrifuging at constant speed and for known time (10 minutes), a 2 ml. aliquot of the medium in specially made centrifuge tube provided with a calibrated capillary. The results of the rate of growth are graphically represented in Fig. 1.

A careful study of the graphs reveal that the growth-promoting efficiency of a given quantity of nitrogen as measured by the rate of growth, is the highest in the case of the "Difco" yeast extract. Next in the decreasing order, follow distillery yeast extract, bran extract, extract of groundnut cake, ammonium sulphate, asparagine and lastly, urea. The extent of the growth of yeast at the end of 16 hours with distillery yeast extract as the source of nitrogen, tends to be higher than what is apparently obtainable with "Difco" yeast extract when the overall growth at the end of the experiment is taken into consideration. During the first ten hours, the rate of yeast growth with bran extract appears to be in no way inferior to that given by the two yeast extracts; the groundnut cake extract, however, has a definitely low efficiency. The rate of growth with extracts of bran and groundnut cake is sharply arrested at the end of ten and sixteen hours respectively, indicating a practical depletion of the more easily assimilable forms of nitrogen. In striking contrast to this phenomena is the behaviour of ammonium sulphate and asparagine, both of which tend to maintain a comparatively low but a steady rate of growth.

Part II. Determination of the "Quality" of the Yeast Crops Harvested on Different Sources of Nitrogen

The organism was grown in Roux flasks containing 100 ml. of the respective media; they were placed in a flat, in a horizontal position, with a view to secure a shallow depth and a large surface for the culture solution. This facilitated aeration of the cultures essential for yeast growth. After 24 hours' growth at room temperature (27°-

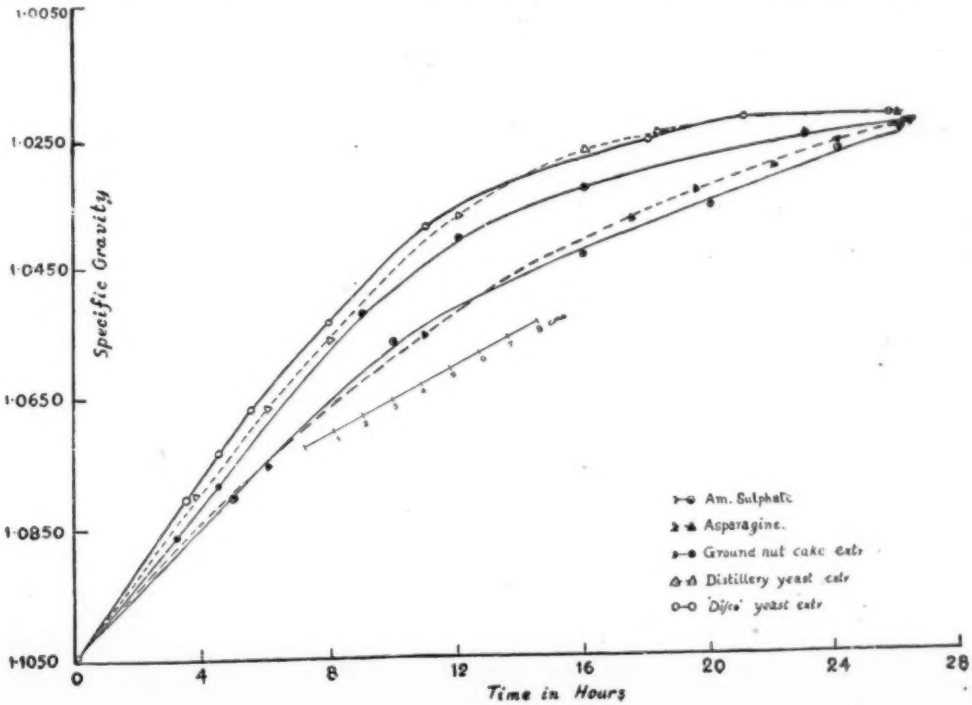

FIG. 2

26° C.) the cultures were collected and washed on the centrifuge. The yeast crop was taken up in saline, made into a thick and uniform suspension, preserved in the ice-chest and its yeast content (on the moisture-free basis) per ml. of the suspension determined by evaporating a known volume of the suspension in a platinum dish, and weighing it to constant weight. The suspension served as the inoculum; a volume of suspension equivalent to 0·4 gm. of moisture-free yeast was employed for every 30 ml. of the experimental mixture for determining the attenuating power of the yeast. The sucrose concentration of the mixture at the start was maintained at 20 per cent. Periodic determinations of attenuation were carried out by noting the specific gravity of the fermenting liquid with the aid of Westphal's specific gravity balance. The results are graphically represented in Fig. 2.

From the graphs given in Fig. 2, it will be seen that the attenuating efficiency of the yeast crops harvested on both the yeast extracts as the source of nitrogen, run very nearly parallel, that of the yeast grown with the groundnut cake extract is definitely low. The yeast crops grown on asparagine and ammonium sulphate process comparatively poor attenuating efficiencies.

In accounting for the higher "quality" of the crops grown on yeast extracts, we have to take into account the vitamins associated with the extracts. Although the strain of the distillery yeast employed in these studies have been demonstrated to be largely independent of external supplies of vitamins, their rates of synthesis by the organism do not appear to be sufficiently high to shorten the period of production of the "pitch". Through a supplementation or fortification of the nutrient media with extracts from natural sources, better harvests of yeasts, with higher attenuating powers can be obtained. In this respect, yeast extracts offer the best source of supplements. These findings should find immediate practical application; steps are being taken to apply these results in large-scale distillery practice.

In conclusion we wish to tender our grateful thanks to Sir J. C. Ghosh, our Director, for the keen interest he has taken in the course of these investigations.

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PRESERVATION OF PRAWNS AND ITS EFFECTS ON THE NUTRITIVE VALUE*

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1. Introduction

PRAWN FISHERY has gained an important position in the economics of the West Coast fisheries of this Presidency. The importance becomes all the more redundant when it is found that the fishery is carried on a large scale during the monsoonic months of May to August when the scope for the other fisheries is limited. The biological aspects of this fishery and the bearing of the ecology of the sea on the fishery are under study in the Biological Station at West Hill. The researches carried out in the Marine Biological Station show that the rainfall has a bearing on the fishery. A heavy monsoon is usually followed by a good prawn fishery. The great influence that prawn fishery holds on the economic balance of the West Coast fishery may be judged better by the following data of the prawns landed on the West Coast for the last three years:—

1943-44	1,55,665	maunds.
1944-45	2,72,805	„
1945-46	1,56,025	„

The remark of Sir Frederick Nicholson "that prawns worth Rs. 15,000 at low price were caught in a single day at Tanur in July", is significant. The peculiarity of this fishery as is seen in the case of the shrimp fishery of Carolina, Florida and Georgia coasts of America is that the fishery is abundant only for a short while at a time interspersed with irregularly longer or shorter periods of slackness. This eventually leads us to the question of treatment of prawns during these periods of glut.

2. Primitive Method of Treatment of Prawns

The most usual or primitive form of treatment of prawns during seasons of glut is to dry them on the beach. Prawns from the boat are carried on to the sea shore and spread over the sand without being washed or cleaned. They are allowed to be dried by mere solar heat. The complete drying takes a period of two to three days provided the weather is normal. If the weather is inclement, the process fails resulting in an enormous waste. Thus much valuable food is strewn along the sands of the beach leaving it to the vagaries of merciful nature which, if favourable, provides it to be marked as "Edible" or otherwise to be used as "Manure".

The analysis of beach-dried prawns as can be seen from Table II below gives a high percentage of sand and shows that the nutritive value is lowered and at the same time provides the consumers with a hard commodity not too palatable. Attempts were made in this laboratory to produce a highly hygienic product in

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which the nutritive value will be least affected and applicable to field production. In this communication, we are giving the methods of semi-drying in the laboratory, its scientific interpretation and its application to the field almost under identical conditions.

3. Principle of Semi-Drying

The principle of semi-drying is one of dehydration combined with the preservative action of common salt. A quantity of moisture (10 per cent.) is removed by boiling and the rest by the salt, combined with solar heat.

4. Laboratory Process of Semi-Drying

The prawns, *Peneus monodon*, was taken for the study as this formed the bulk in the landings of prawns. The prawns were washed well in fresh water and put in 5 per cent. boiling brine (common salt) contained in a tinned copper vessel. They were allowed to remain in this solution of boiling brine until they assumed a pinkish colour and floated on to the surface. This floating to the surface and the appearance of pinkish colour are the criterion for their removal from the solution. This phenomena happen in a short period of four to six minutes. They were then laddled out and spread on glass plates for cooling and then shelled. The shelling was done by hand. The shelled flesh was then kept immersed in saturated brine (25 Be.) for fifteen minutes, to allow the ready penetration of salt. It was then dried in an air-oven at 50° C. for four hours. The final dried product had the appearance of fine pink coloured lozenges.

5. Application to Field Work

The experiment was repeated on a technological scale except that the drying was done on raised bamboo barbacues, with solar heat (90° F.). The period of six hours (10 a.m. to 4 p.m.) was found necessary to dry the product to the required consistency on a sunny day. No notable variation was observed, from the laboratory procedure in its application to the field.

6. Methods of Analysis

The method of analysis followed was the same as described by the Association of Official Agricultural Chemists, Fifth Edition, Washington, 1940. The minced sample was analysed for its moisture content as usual by drying in an air-oven at 100° C., nitrogen by the Kjeldahl method from which the protein was arrived at by employing the usual factor 6·25, ash by heating the sample to dull-red heat after initially driving out all carbonaceous matter, fat by extraction in a thimble in a Soxhlet's apparatus with ethyl ether for about 12 hours, the carbohydrate by difference, phosphorus by the ammonium molybdate volumetric method, calcium by the McCrudden's permanganate method, and iron by the Elvehjem-Kennedy method, colorimetrically by using a Helige-Duboscq colorimeter.

The following table gives the values of analysis of fresh and semi-dried prawns :—

Table I

Particulars	Water	Percentage composition on moisture-free basis								
		Proteins	Ash	Fat	Carbohydrates	P.	Ca	Fe	Insolubles	NaCl.
	%	%	%	%	%	%	%	Mgm%	%	%
1. Fresh prawns (*Peneus monodon*)	78·46	81·91	7·15	1·90	9·04	1·59	1·01	21·36	—	—
2. Semi-dried prawns (*Peneus monodon*)	40·60	62·59	24·33	1·65	11·43	1·05	1·05	17·82	0·40	17·18
3. Beach-dried Prawns (*Peneus monodon*)	22·65	59·91	30·17	0·93	8·99	1·66	0·54	8·68	19·86	

Table II

No.	Raw weight of prawns	Weight after boiling	Quantity of 25 Be brine used	Conc. of this brine after treatment	Shelled weight	Final weight
1.	85 Lbs	75·5 Lbs	25 Lbs.	18 Be.	23·25 Lbs	14·10 Lbs
2.	125 ,,	109 ,,	40 ,,	18·5 ,,	40·5 ,,	21·75 ,,
3.	100 ,,	89 ,,	30 ,,	17 ,,	34 ,,	16 ,,
4.	200 ,,	175 ,,	70 ,,	19·5 ,,	66 ,,	28 ,,
5.	125 ,,	107 ,,	40 ,,	18·5 ,,	40 ,,	21 ,,

The above table gives how the product is altered by the different processes involved in the method.

7. Discussion

It is seen that the moisture content in the processed stuff is as high as 40·6 per cent., yet the preservation is effected by the salt which is present in high concentration as can be judged from the ash content which analysed 17·18 NaCl. The low protein content and high salt content are accounted for by the penetra-

tion of salt (even in a short interval) into the tissue cells by osmosis, extracting out the water as well as some water and salt soluble nutritive elements along with it. Yet the loss in the nutritive elements is not appreciable. The low weight (about one-sixth) of the final product is partly owing to the removal of the shells which accounted for 50 per cent. of the loss and partly by the dehydration of salt and sun's heat. Field experimental product also yielded identical results. The only dissenting factor is the slightly high amount of labour involved in the shelling by hand. Studies in the shelling by "dancing of the prawns" as practised in Florida, are under way.

The product is found to retain its prawn flavour and with slight soaking is an excellent and nutritive article of diet. If packed in deal-wood boxes lined with butter-paper and stored in a cool dry place, it is found to remain good for at least two months.

8. Resume

(1) A method of preservation of prawns (*Peneus monodon*) by semi-drying is enunciated. Semi-drying retains the nutritive elements and keeps the product supple at the same time preserving it for a fairly good period.

(2) The laboratory details are applied to field-work.

(3) Analysis of prawns, fresh, beach-dried, and semi-dried, are gvien.

Our thanks are due to Sri M. Devidas Menon, B.Sc, (Hons.), of the Marine Biological Station, West Hill, for identifying the species and evincing a keen interest in the paper.

1. Association of Official Agricultural Chemists, *Methods of Analysis*, 1940, 5th Edition, Washington. D. C. 2. Fitting, A. W., *Canning Shrimp–Mem. S.* 10 *Dept. of Commerce, Bureau of Fisheries*, Washington. 3. *Bulletins of the Madras Fisheries Department.* 4. Chacko, P I., "Prawn Curing in Madras," *Ind. Farming*, June, 1944, 5, 6. 5. Chidambaram, K., and Venkataraman, R. S., "Prawn and Crab Fishery in Madras," *Ind. Farm.*, October, 1944, 5, 10. 6. Chopra B., "Prawn Fishery of India—Presidential Address of the Indian Science Congress," 1943. 7. Chidambaram, K., and Devidas Menon, "Correlation of West Coast Fisheries with Plankton and certain Oceanographical Factors," *Proceedings of the Indian Academy of Sciences*, 1945, 22. 8. "Description of the Shrimp drying industry of the Bantaria region," *Mem. S.* 9–*Bureau of Fisheries*, Washington, 9. John, C. C., *Prawn Industry of Travancore.* 10. Lund, F. P., "Canning Crab and Shrimp Meat," *Mem S.* 96. *Bureau of Fisheries*, Washington. 11. Devidas Menon, M., "Prawn Culture in Paddy fields in Cochin State–A report to the Marine Fisheries Development Board, Madras" (Unpublished). 12. Scofield, W. B., "Shrimp Fisheries of Carolina," *Mem. S.* 177. *Dept. of Commerce Bureau of Fisheries*, Washington. 13. "Shrimp Industry of South Atlantic and Gulf States," *Mem. S.* 9. *Dept. of Commerce, Bureau of Fisheries*, Washington. 14. "Statistical Statements of the Fisheries Branch of the Dept. of Industries and Commerce, Madras," years 1943–46.

THE ICAROSCOPE

THE icaroscope is a new optical device for observing objects in the sky near and in front of the sun, developed as a result of wartime research. It was described at the October meeting of the Optical Society of America in New York by Dr. Brian O'Brien, of the Institute of Optics, University of Rochester. The principle of phosphorescence is employed, using special kinds of phosphors with strong afterglow properties which are not much greater, however, for exposure to the sun itself than for exposure to the sky around the sun. This achieves a reduction in the intensity of the solar image sufficient to permit observation of the sun and surrounding sky simultaneously.

The afterglow image does not persist very long, nor is it desirable that it do so if scanning of the sun and sky is to take place. The icaroscope is fitted with a rotating shutter which regularly interrupts the sunlight striking the screen which is coated with the phosphor. Each time the phosphor is exposed, it is energised to emit the afterglow image. Another similarly rotating disk shields the screen from the observer while the sun is shining on it, but allows him to observe the screen between exposures, when the afterglow image is visible. The contrast between the sun and its surroundings is reduced to a small fraction of its original value. At a rate of 90 exposures a second, persistence of vision obscures the fact that the image is not continuous.

The entire icaroscope, including optical parts for viewing the image, is small enough to be carried almost as easily as a pair of binoculars.

A use for the icaroscope which was probably not foreseen during its development was the observation of the initial flash of the above-water explosion of the atomic bomb at Bikini this summer. It made possible direct visual observation of that extremely intense light source.

—(*Courtesy of "Sky and Telescope,"* No. 61, November 1946, p. 11.)

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A RELATION BETWEEN THE COMPRESSIBILITY AND THE MELTING POINT OF THE ALKALI HALIDES

IN a note[1] published in *Current Science*, the present author showed that a simple relation exists between the melting points, T_m, of the metals crystallising in the cubic system, their shear constants $(C_{44})_0$ and their interatomic distances r_0, the last two being measured at the absolute zero of temperature. It was found that in each case

$$\frac{(C_{44})_0\, r_0^3}{kT_m} \approx 64 \qquad (1)$$

where k is the Boltzmann constant. Curiously enough, this relation is not obeyed by the other class of solids having the simplest structure, namely, the alkali halides. It is, however, found that they obey an analogous relation[2] between the compressibility at the absolute zero $(\chi)_0$ and the melting point, which in its turn is not obeyed by the metals.

$$\frac{r_0^3}{\chi_0\, kT_m} \approx \text{constant}. \qquad (2)$$

This is shown in the table where the room temperature data, of both the compressibility and the interatomic distance, have been used, in order to avoid the difficulty of extrapolation to the absolute zero. Data have been taken from Huggins[2] where references have been given.

TABLE

Salt	$\frac{r_0^3}{\chi_0\, kT_m}$
LiF	43·4*
LiCl	41·0
LiBr	42·7
LiI	45·7
NaF	33·6
NaCl	35·3
NaBr	36·9
NaI	37·6
KF	36·3
KCl	38·2
KBr	38·7
KI	36·0
RbF	38·4
RbCl	38·3
RbBr	38·3
RbI	40·9

* Slater's[3] value of compressibility gives the ratio as 33·6.

The relation (2) can be easily obtained by equating the Einstein and the Lindemann formulæ (3) and (4) respectively for the Debye characteristic frequencies.

$$\nu = \frac{\text{constant}}{\chi^{1/2} \cdot A^{1/3} \cdot \rho^{1/6}} \qquad \text{(3) Einstein.}$$

$$\nu = \text{constant} \times \sqrt{\frac{1}{A \cdot V^{2/3}}} \qquad \text{(4) Lindemann.}$$

A in the formulæ stands for the atomic or the molecular weight, ρ for the density, and V for

the atomic or the molecular volume. The fact that (2) is not obeyed by the metals, suggests that in their cases a modified Einstein formula with $\frac{1}{(C_{44})_0}$ in place of χ_0 should give a better value of the characteristic frequency. Actual calculations seem to support this conclusion.

Both the relations (1) and (2) can, however, be derived in a rough way on the basis of the Lindemann theory of melting. According to this view, the average amplitude of vibration at the melting point bears a constant ratio to the interatomic distance. The reason, for the difference in the formulæ for the metals and the alkali halides, is then seen to lie in the fact that in the former case, the force constant between the nearest atoms is approximately obtainable from $(C_{44})_m$ and in the other from the reciprocal of the compressibility.

Dept. of Physics, BISHESHWAR DAYAL.
Benares Hindu University,
November 17, 1946.

1. Dayal, *Curr. Sci.* 1945, **14**, 261 2. Huggins, *J. Chem. Phy.*, 1937, **5**, 143. 3. Slater, *Phys. Rev.*, 1924, **23**, 488.

BLAINI-TALCHIR

DURING recent investigations of dam sites on the Kosi river in Eastern Nepal certain exposures have been found which help to elucidate the age and nature of the Blaini boulder bed in the Western Himalaya. The vicissitudes of opinion about this rock formation may be judged by reference to the literature ending with letters by K. P. Rode and myself to *Current Science* three years ago.[1] East and west of Barahakshetra (26° 52′ 36″ : 87° 10′ 7″) and extending on both banks of the Kosi river, there is a zone of rocks, some of them Gondwana in age, which is bound to the south by a thrust plane against the Nahan series and which is overlain by the thrust unit of the Dalings. The general sructural disposition is similar to that in the Darjeeling-Teesta foothills with the difference that the Gondwana and associated rocks in the Kosi area occur not only south of the Daling thrust but appear to crop out northwards in the form of a tectonic window, below the Daling series, which probably extends laterally up the Sun Kosi and Tamur rivers. From the point of view of this discussion the relevant rock types, all in close association are (1) Boulder Slate, (2) Carbonaceous Shales, (3) Dolomite.

The boulder slate is seen in numerous exposures, but best of all on the water-smoothed exposure below normal monsoon flood level on the left bank of the Kosi some quarter-mile upstream from Barahakshetra, where it may be about 200 feet thick. Elsewhere it is probably thicker. Both cleaved and uncleaved types are found and both are identical to the Blaini rocks between Solon, Mussoorie and Lansdowne. A freshly fractured surface of the cleaved type of boulder slate frequently discloses nothing more than a dark gritty slate, apparently without inclusions. Weathered surfaces show, however, that there are numerous angular pebbles of dark slate, grey quartzite, vein quartz and pale limestone set in a gritty matrix (Fig. 1). Under the microscope the matrix is seen to be typical of an ungraded tillite.

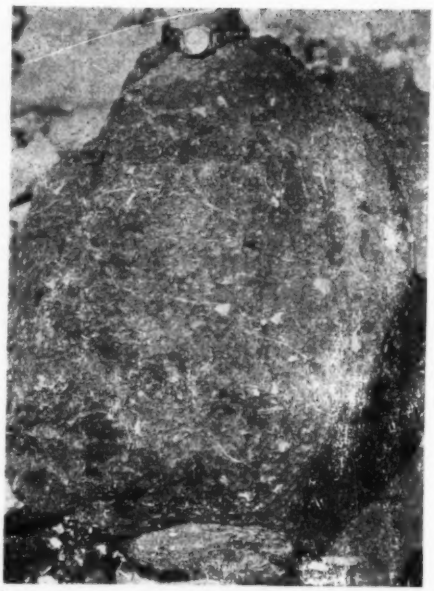


FIG. 1. Boulder of Boulder Slate of Blaini type and probable Talchir age. Kokaha Nala, Nr. Barahakshetra, Kosi River, Nepal.

FIG. 2. Impure highly sheared coal adjacent to and embedded within Dolomite, with "horses" of dolomite in coal. Kokaha Nala, Nr. Barahakshetra, Kosi River Nepal.

Several seams of highly sheared black carbonaceous shale have been found, always in proximity to boulder slate, and associated with less carbonaceous shale, grey sandstone and dolomite. The carbonaceous matter is frequently converted to graphite, particularly around rock inclusions. The dolomite forms the southern limit of the series and is thrust upon the Nahan series with a strong tectonic discordance. In two instances carbonaceous shale lies embedded within dolomite, which in places is metasomatised and partially replaced by silica. The carbonaceous shale resembles exactly in hand specimen many of the less pure uneconomic coal seams of the Gondwana series in the Darjeeling foothills, such as near Kalijhora (26° 56′:88° 27′), which are extremely high in ash and quite unburnable. The following analyses of the Kosi Coaly rocks were carried out by Dr. Dutta Roy in the laboratory of the Geological Survey of India :—

	15 ft. Seam Kokaha Nala (mean of 2 analyses)	7 ft. Seam Kokaha Nala (mean of 2 analyses)
Moisture	1·01%	2·17%
Volatile Matter	5·05	4·52
Fixed Carbon	6·10	3·46
Ash	86·36	89·27
Carbon Dioxide	1·48	0·58
Fuel Ratio	1·2	0·77

This is not the occasion to do more than mention the anomalous characters and position of the Kosi carbonaceous rocks. Virtually all the Lower Tertiary and Gondwana coals of the outer Himalaya between Jammu and Darjeeling have undergone strong shearing and possess fuel ratios ranging from 2·5 to 8·0. The average fuel ratio, determined from 150 analyses of Eocene coals from Jammu is 4·7. For five Darjeeling Gondwana coals listed on page 50 of *Mem. Geol. Surv. Ind.*, LIX, the ratio is 4·73. Even the tree stems found so often in the Lower and Middle Siwaliks (late Tertiary) have fuel ratios ranging between 1·30 and 2·0. Yet in the samples collected from the Kosi region the ratio is as low as 0·77-1·2, even after allowance had been made by Dr. Dutta Roy for the calcium and magnesium carbonates present in the ash which dissociate on carbonisation with the liberation of carbon dioxide. It is possible that the Kosi carbonaceous shales represent coal which had been locally eroded on the shore of the Permo-Trias sea and was redeposited, concomitantly with the precipitation of dolmite out of solution, in the marine waters.

In the present context the association of the three rock types enumerated above is of importance in connecting up the Western Himalaya with East Nepal, Darjeeling and the Peninsula. Firstly, the proximity of the Kosi boulder slates, resembling tillite, with carbonaceous graphitic shale, which is very similar to coals of known Gondwana age in the Darjeeling foothills, is a strong indication that the boulder slate is in fact equivalent to the Talchir boulder bed. Secondly, the stratigraphical relationships between the rocks in the Western and Eastern Himalaya may be compared :—

Inferred Age	Western Himalaya	Eastern Himalaya
Permo-Trias	Krol limestones and dolomites	Barahakshettra Dolomite
Permian	Banded carbonaceous slates (Blaini Slates) (banding of Varve type)	Carbonaceous and graphitic slates, sandstones. Coal in Darjeeling
Upper Carboniferous	Blaini boulder beds often cleaved to boulder-slate	Boulder bed locally cleaved to boulder slate (Talchir)
? Devonian	Nagthat Series	Series of white and purple quartzites; purple, green, and dark slates (position at present uncertain, but below the Gondwanas)

While more work is required in the intervening region, 500 miles in length, between the Kosi and Naini Tal, before definite conclusions can be drawn, it seems very probable that the boulder slate of the Kosi region and the Blaini boulder bed of the Western Himalaya are equivalent, that the age of the Blaini is in fact Talchir or Upper Carboniferous, and that it is glacial in origin. On grounds of structure as mapped in the Solon-Mussoorie-Lansdowne area, I had previously disputed K. P. Rode's contention that the Blaini boulder bed is a Tertiary tectonic breccia devoid of stratigraphical significance. The opinion of the Geological Survey of India is now seen to be strengthened by the disposition of the Kosi rocks.

It may be remarked that in 1933 L. R. Wager found a boulder bed on Lachi hill, in north-east Sikkim.[2] I saw his specimens when in England that year and visited Lachi in 1934.[3] This boulder bed very closely resembles the uncleaved Talchir boulder beds of the Peninsula. The recent topographic survey of Sikkim establishes that the geographical co-ordinates of Lachi hill are 28° 1′ 12″:88° 44′ 15″ and its altitude about 18,500 feet.

It is evident that the Gondwana ice sheet spread well into the area which is now included within the Himalaya and that in the Kosi region there was a somewhat longer duration of continental conditions than obtained further north-west. But whereas the Talchir glaciation and impure coal (Kosi), and the banded Varved carbonaceous slates (Solon-Naini Tal), were followed in those areas by non-fossiliferous marine rocks, in Northern Sikkim and the Salt Range the marine conditions were favourable to the existence of life.

The top beds of Lachi series of L. R. Wager contain marine Permian fossils. These are succeeded by the Tso Lhamo series, containing a well-developed Muschelkalk fauna, which I located in 1934.[4] In the Salt Range the boulder bed is followed by fossiliferous marine Permian and Trias rocks. Somewhere between the Kosi-Krol zone and the North-Sikkim/Salt Range zone there must have been an ecological boundary separating marine waters. South of this boundary conditions inhibited the existence of life, whereas north of it there was an abundant fauna. As to how far the north edge of the Gondwana continent and the subsequent ecological barrier have been telescoped and displaced by the later Himalayan movements cannot at present be indicated.

Engineering Geology Section,
Geological Survey of India, J. B. AUDEN.
Calcutta,
November 11, 1946.

1. *Rec. Geol. Surv. Ind.*, 1908, **37**, 129. *Mem. Geol. Surv. Ind.*, 1928, **53**, 132. *Rec. Geol. Surv. Ind.*, 1934, **67**, 365. *Op. cit.*, 1937, **71**, 414. *Proc. Ind. Acad. Sci.*, 1943, **17**, 157. *Curr. Sci.*, 1943, **12**, 299. *Op. cit.*, 1944, **13**, 74. 2. "*Everest* 1933," 1934, p. 333. 3. *Rec. Geol. Surv. Ind.*, 1935, **69**, 151. 4. *Ibid.*, p. 152. *Op. cit.*, 1939, **74**, 172.

ALPHA-NAPHTHOL AS AN INDICATOR

THE use of diphenylamine as an internal indicator in the titration of ferrous ions by potassium dichromate is well known.

Since alpha-naphthol and beta-naphthol on oxidation are reported to undergo a transformation into dinaphthols[1] which have respectively violet and greenish colorations, it was thought desirable to study the use of these reagents as internal indicators in the above titration.

To 10 c.c. of the ferrous salt sol., 10 c.c. of the phosphoric-sulphuric acid mixture was added, followed by 20 c.c. of dil. sulphuric acid. Finally 5 drops of the alpha-naphthol reagent (1% solution in con. sulphuric acid) were added and the mixture titrated against decinormal dichromate. As the titration proceeded, a green colour developed and when the reaction was complete the colour was at once discharged. This change is sufficiently well marked to signify the end-point. For the sake of comparison, titrations were carried out with diphenylamine as an internal indicator. An average of three titrations gave the following readings: (*a*) with diphenylamine as indicator, 10·05 c.c. dichromate; (*b*) with alpha-naphthol as indicator, 10 c.c. dichromate.

It may be pointed out that, with diphenylamine as internal indicator, the dichromate reading is usually 0·05 c.c. higher than with potassium ferricyanide as external indicator.

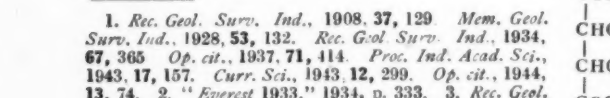
This indicator has certain drawbacks. It fails to work in back-titration, as well as with dilute reactants. If a ferric salt solution is reduced by stannous chloride, this indicator fails to work in subsequent titration with dichromate. The disappearance of a colour is never so much advantageous as appearance of a colour. Yet the use of alpha-naphthol as an internal indicator in this titration is worth introducing. Beta-naphthol gave no satisfactory change of colour.

Public Health Laboratory, J. W. AIRAN.
Kolhapur State, G. N. PANDIT.
Kolhapur,
October 9, 1946.

1 Bernthsen, *Organic Chemistry*, Tr., Sudborough, 1944, Edition, p. 574.

INDUCED OXIDATION OF TARTARIC ACID BY POTASSIUM DICHROMATE WITH FERROUS SULPHATE AS INDUCTOR

TARTARIC ACID is slowly oxidised by chromic acid or potassium dichromate to meso-oxalic acid. In acid medium it is completely oxidised to carbon dioxide and water. The different oxidation stages of tartaric acid are as under:



The reaction is extremely slow but addition of ferrous sulphate to an acidified solution of tartaric acid induces the oxidation and then the oxidation takes place as fast as the solution of chromic acid or potassium dichromate is added until the tatronic acid stage is reached. The mixture gives test for ferrous ion. Further reaction takes place with a slightly diminished speed and in this later stage the mixture shows the presence of ferrous ion only on standing for some time indicating that the ferric ions first formed oxidise the organic acid molecules and are themselves reduced to the ferrous condition. Further reaction beyond the meso-oxalic acid stage is apparently not induced by ferrous sulphate.

Similar investigation on oxalic acid reveals that unlike in the above case, (i) the reaction between oxalic acid and potassium dichromate is not induced by ferrous sulphate, (ii) but that potassium dichromate rapidly oxidises ferrous sulphate and simultaneously oxalic acid with a slow rate.[1]

Experiments were also made using potassium permanganate as an oxidising agent. It is interesting to note that ferrous sulphate does not induce the slow reaction between tartaric acid and potassium permanganate. An experiment with oxalic acid brought out a noteworthy fact that a mixture of ferrous sulphate and oxalic acid can be completely oxidised by titrating with potassium permanganate *in cold*. No heating is necessary as is usually recommended for the titration between potassium permanganate and oxalic acid. Apparently, however, this is not a case of induction by ferrous sulphate as even without addition of ferrous sulphate the reaction between potassium permanganate and oxalic acid takes place quickly.

In all the above experiments decinormal solutions of the various reagents were used.

Luther and Rutter[2] explained the induced reduction of chromic acid in presence of some metallic salts as inductors on the basis of pro-

duction of quinquevalent chromium ion which is relatively more reactive. Similar explanation was put forward by Wagner and Preiss[3] for the induction of the reaction between chromic acid and iodide by ferrous salts. We believe that it is not the quinquevalent chromium ion but the chromium chromates which may be formed at intermediate stages in the reduction of chromic acid or chromates that are responsible for the induction process. In this connection it may be stated that it has been observed in this laboratory that at the intermediate stages during the reduction of chromic acid and chromates by tartaric acid the formation of chromium chromates is indicated. The reduction of chromic acid or chromates by oxalic acid on the other hand is not stagewise and is not accompanied by the formation of the chromium chromates.[4] This explanation can account for most of the above experimental observations.

Further work is in progress.

Our thanks are due to Prof. D. B. Limaye for kind encouragement.

Department of Chemistry, D. A. V. College, Sholapur, November 15, 1946.

D. S. DATAR.
S. N. KELKAR.

1. *Cf.* Viswanadhan and Rao, *Curr. Sci.*, 1943, **12**, 327. 2. Luther and Rutter, *Z. Anorg. Chem.*, 1907, **54**, 1. 3. Wagner and Preiss, *Ibid.*, 1928, **168**, 265 4. Datar and Kelkar, *J. University Bombay*, under publication.

A COMPARATIVE STUDY OF ACID AND ENZYMIC EXTRACTIONS OF NICOTINIC ACID FROM FOODSTUFFS

THE usual procedure followed for the extraction of nicotinic acid from foodstuffs, is by the use of either acid or alkali. This procedure is so drastic that often highly coloured extracts—especially from plant materials—are obtained, which necessitate separate blank estimations in every case. Further, improper evaluation of the blank values has been shown by Melnick and Field (1941) to yield erroneous values. Extraction of nicotinic acid has also been achieved by the use of enzymes, *viz.*, taka diastase and papain (Chedelin and Williams, 1942) and by an enzyme preparation from the pig's intestinal mucosa (Bhagvat, 1943). Enzymic extraction of nicotinic acid from foodstuffs yields colourless or very slightly coloured extracts, thereby eliminating the blanks. The object of the present investigation was to compare the nicotinic acid values of foodstuffs on their extractions with 2N HCl and with an enzyme preparation from pig's intestinal mucosa.

The enzymic extracts of foodstuffs were prepared and tested as described by Bhagvat (*loc. cit.*).

The acid extracts were prepared by extraction of 1-10 gm. of the foodstuffs with 50 ml. of 2 N HCl for 15-20 minutes in the water-bath. The extracts were filtered, neutralised and treated with basic lead acetate in order to remove interfering substances. The excess of lead was removed by H_2SO_4 and the nicotinic acid in these extracts was estimated by the cyanogen-bromide method. Since the acid extracts were coloured blank estimations to evaluate the residual colour were done. In every case, two blank estimations—(1) dilution blank—a known aliquot of the extract—was diluted with water to a definite volume and the colour compared directly in the colorimeter; and (2) aniline blank (same as dilution blank, but instead of water, aniline was used), were carried out. The results are given in the table.

Nicotinic Acid Content of Foodstuffs

Materials	μg nicotinic acid per gram			
	Acid extraction			Enzymic extraction
	Uncorrected	Corrected using dilution blank	Corrected using aniline blank	
Green gram	41.5	14.8	10·0	16·0
Green gram (sprouted)	7.9	0.75	−1·7	9·5
Horse gram I	18.9	13.6	9·5	15·9
,, ,, II	22.25	10.1	8·9	17·9
Cow pea	8.1	—	—	15·0
Cow pea (sprouted)	12.7	5.4	6·2	14·7
Black gram	24.15	7.5	−0·4	15·1
Wheat	44.5	29.1	26·9	15·7
Wheat bran	90	—	—	74·0
Barley	34.7	26.9	26·9	14·3
Groundnut (ether extracted)	179.5	140.0	139·5	69·0
Mustard	60 6	35.6	34·5	26·1
Sesame	42.9	35.4	34·6	22·8
Dried yeast—				
Torula	213.0	—	—	215·6
,, Brewer's	465	—	—	472·0
Sheep Liver	107	—	—	107

The nicotinic acid values of foodstuffs (with the exceptions of yeast and liver) vary appreciably with the method of extraction employed. Generally a lower value for nicotinic acid was obtained for pulses by acid extraction than by enzymic extraction. Further a discrepancy was noted between the two series depending upon which blank value was used in the calculations. Acid extraction of cereals and oil-seeds, however, yielded higher values for nicotinic acid than those obtained by the enzymic method. Whether these higher values are due to the presence in cereals and oil-seeds of a precursor of nicotinic acid or a non-specific chromogen, is a matter for future investigation.

The enzyme preparation used in this investigation contains a large and varied array of enzymes which will liberate and extract nicotinic acid from its biological combinations. Taking into consideration the specificity of enzyme action and the presence of a similar type of enzymes in the human body, it might not be too premature to suggest that the values of nicotinic acid obtained by the enzymic extraction represent those which are biologically

availa'le. Further experiments, however, are necessary to prove this point.

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November 11, 1946.

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INFLUENCE OF YEASTS ON PROTOZOAL ACTIVITY IN SEWAGE

IN the course of our studies on the fundamental role of protozoa in sewage purification,[1–3] some interesting observations have been made in regard to the influence of yeasts, when introduced along with the protozoa in different combinations into sterilised sewage, on the purification process.

We have carried out a number of experiments by inoculating cultures of *Saccharomyces cerevisiæ* (one of the most commonly occurring species in certain trade effluents and sewage) together with *Epistylis* sp. (the indicator organism for well conditioned sludge) into sterilised sewage and bubbling air through the suspensions. One set of these experiments is briefly described below.

Samples of actively fermenting yeasts were treated as follows before they were inoculated along with the protozoa into sewage:— (i) the yeast inoculum consisted of both the yeast cells and the fermented liquor, in the form of mixed suspension (100 c.c.); (ii) the inoculum was only the yeast cells (about 2·5 g. in the wet condition, contained in 100 c.c. of the mixed suspension) filtered and carefully washed with ammonia-free distilled water in order to make the cells free of acid; (iii) 100 c.c. of the fermented liquor without the yeast cells (the filtrate from the previous preparation) was employed; (*iv*) the washed cells (acid-free, about 2·5 g. in the wet state) were autoclaved at 15 lbs. pressure for 30 minutes, and the cooked material as such was used; and (*v*) the water extract of the autoclaved material (100 c.c.) was the inoculum. For each of these yeast preparations two litres of heat-sterilised sewage was employed, so that the added yeast suspensions formed about 5 per cent. by volume of the sewage; such a proportion of domestic sewage to trade effluent (as represented by yeast additions) obtains at certain industrial centres. The protozoan inoculum for these experiments consisted of 20 c.c. of fresh *Epistylis* sp., washed well in ammonia-free distilled water. The progress of purification of the sewage samples in the different cases was determined by examining the sludges and the supernatants at frequent intervals during a period of 96 hours. The results of chemical analyses of the supernatants and microscopic examination of the protozoa during the first 24 hours after the treatments are given in Table I.

TABLE I

Treatments of sewage	One hour after the treatments					After 24 hrs. of aeration		
	Supernatants				Microscopical observations on the protozoa	Supernatants		Condition of the protozoa
	Oxygen absorbed from potassium permanganate in 3 mins.	4 hrs.	Free and saline ammonia (N)	Albuminoid nitrogen (N)	pH	Oxygen absorbed from potassium permanganate in 4 hours	pH	
Protozoa alone (*Epistylis* sp.) control series	1·75	4·08	1·40	0·40	7·6	Extremely active	0·96	7·6	Active
Protozoa & yeast cells (*Saccharomyces cerevisiæ*) together with the fermented liquor	19·60	46·00	3·12	1·02	6·0	Inactive	50·40	6·1	Dead
Protozoa & washed yeast cells	1·84	4·08	1·25	0·62	7·6	Very active	1·12	7·5	Active
Protozoa & yeast liquor with the cells	17·20	46·00	3·57	1·02	6·0	Inactive	50·40	6·1	Dead
Protozoa & yeast cells washed and autoclaved	1·92	4·24	1·40	0·89	7·5	Very active	1·04	7·4	Active
Protozoa & water extract of the autoclaved yeast material	1·76	4·08	1·56	0·62	7·6	Very active	0·96	7·6	Active

The results of chemical analyses of the supernatants are expressed as parts per 100,000.

The results of analyses of samples of the supernatants taken during the subsequent periods of observation consistently showed that the purification of sewage was adversely affected in presence of the actively fermenting yeasts and was traceable to the products of yeast fermentation (the acids, alcohols and related products) rather than to the yeast cells themselves. Addition of lime to the yeast liquor (neutralising the acidity) was found efficacious in the prevention of these adverse effects.

The sensitiveness of the protozoa to reaction and other conditions is, therefore, of great technical importance and emphasises the need for trade effluents to be discharged into the sewers in equable flows so that the whole sewage is not affected.

The above observations would explain the cause of a somewhat mysterious breakdown in one of the earlier Activated Sludge installations in England where flushes of brewery waste were liable to enter the sewer.[9]

Dept. of Biochemistry, Indian Institute of Science, Bangalore, *October* 10, 1946.

S. C. PILLAI.
M. I. GURBAXANI.
V. SUBRAHMANYAN.

1. Pillai, S. C., *Curr. Sci.*, 1941, **10**, 84. 2. —, *Ibid.*, 1942, **11**, 431. 3. —, *Ind. Med. Gaz.*, 1942, **77**, 118. 4. Pillai, S. C., and Subrahmanyan, V., *Nature*, 1942, **150**, 525. 5. —, *Sci. and Cult.*, 1943, **8**, 376. 6. —, *Nature*, 1944, **154**, 179. 7. —, *Sci. and Cult.*, 1945, **11**, 75. 8. —, *Ibid.*, 1946, **11**, 392. 9. Martin, A. J., "The Activated Sludge Process." Macdonald and Evans, 1927, p. 54, and private communication from Dr. G. J. Fowler.

VERNALISATION RESPONSE OF CULTIVATED INDIAN WHEAT

WORKING with seven strains of Indian wheat, Kar,[1] in a recent article in *Nature*, has put forward the interesting conclusions that (*a*) certain varieties of cultivated Indian wheat differ in their response to the vernalisation process from their closely allied relatives of the temperate region and (*b*) to induce significant earliness from prechilled seeds of cultivated Indian wheat, it is essential that seedlings be subjected to a certain number of long days. Kar writes: "Sen and Chakravarti[2] have reported significant response in certain strains of cultivated wheat in higher altitudes of the Almora Hills, but the light period available to the seedlings at the subsequent photostage was not mentioned."

The daylength to which the seedlings were subjected in "randomised blocks with four replications", in sowings of October 1943 and February 1944, was not specifically mentioned in the note[2] (1945), since from the sowing dates the subsequent photoperiods of this region could easily be inferred. Data of the prevailing daylengths of Almora, however, have been given in an earlier publication[3] (Sen and Chakravarti, 1942), in which the effect of different photoperiods on the vegetative phase of control and vernalised mustard T. 27 was observed in a series of ten successive sowings, beginning from April 1940 to March 1941. As regards the agronomical possibilities of subjecting wheat seedlings to photoperiods other than the prevailing daylength of the region, it has already been pointed out by Sen[4] (1940) that light vernalisation of seedlings has practical possibilities only for a crop like rice or for winter vegetables which are normally transplanted. In small experimental trials, Sen and Chakravarti[5] (1943-44) have found that subjecting seedlings of Soybean C.2 and L.S.S. Cotton to a photoperiod of 9½ hours for only two weeks hastened flowering—six weeks in Soybean C.2 and three weeks in L.S.S. cotton, but the actual labour and cost involved in attempting to shorten the daylength of seedlings in cultivator's fields in India would be prohibitive.

As a result of marked vernalisation response observed in 1943 by Sen and Chakravarti[2] in a few strains of cultivated Indian wheat, a systematic study of the vernalisation response of the available strains has been in progress since 1944, under the climatic conditions of Almora (Lat. 29° 45′ N. Long. 79° 40′ E.) and New Delhi (Lat. 28° 35′ N. Long. 77° 12′ E.). Pure strain seeds obtained from the Imperial Agricultural Research Institute, New Delhi, were vernalised at the Vivekananda Laboratory, Almora, and sown simultaneously with their corresponding controls in similar stage of germination in randomised field plots in Almora and New Delhi. The first sowing of 150 strains was undertaken in February 1944. From the observed vernalisation response of these 150 strains, 63 strains were selected for normal seasonal sowing in October 1944. Investigation with another 150 strains is still in progress, but results so far obtained and reported[6] (1944-45) contradict the generalisations of Kar (1946) about Indian wheat.

The vernalisation responses of the Indian wheat in which an earliness of over ten days in ear emergence has been observed in Almora and in New Delhi in normal seasonal sowings are given in Table I. The prevailing daylength from October 11th begins to diminish from 11·6 hrs. (Almora) and 11·7 hrs. (New Delhi) reaching a minimum of 10·2 hrs. (Almora) and 10·3 hrs. (New Delhi) by the third week of December. After Christmas it begins to increase, reaching the same daylength as of October 11th by March 6th. Since sowings in Almora were on October 14th, and in New Delhi, on October 23rd, all vernalised plants which eared within 143 days in Almora and 134 days in New Delhi had to complete their vegetative phase under short days. It will be seen from Table I that neither in Almora nor in New Delhi were the vernalised seedlings of the various strains of wheat mentioned in the table subjected to any long day, yet the observed earliness in ear emergence was of agricultural significance. This fact clearly shows that prechilled seeds of some of the cultivated Indian wheat will produce plants under short days which give significant vernalisation response. Furthermore, though the plants from vernalised seeds had to complete their vegetative phase under similar short days both in Almora and New Delhi, the vegetative periods of all these strains were longer in

TABLE I

Showing vegetative periods in days of (C) control and (V) vernalised cultivated Indian wheat (I) Almora sowing—October 14, 1944, (II) New Delhi sowing—October 23, 1944. Number of plants is given in brackets.

Strain	(C)	(V)	Earliness (C–V)
(Baluchistan Suraki	(I) 164·7 (30 (II) 140·1 15	135·8 25) 123·5 14	29·0** 16·6**
(Punjab) T·6	(I) 143·8 (28 (II) 125·4 9)	129·3 18) 111·3 (20	14·5** 14·1**
(Punjab) T·7	(I) 154·2 (32 (II) 125·4 17)	132·8 21 110·7 9	11·4* 14·7**
(Punjab) T·20	(I) 145·5 34 (II) 125·3 (20	127·7 34 112·7 22)	17·8** 12·6**
(Punjab) T·21	(I) 149·3 27 (II) 123·2 20)	136·9 18 110·3 21)	12·4* 12·9**
(Punjab) 9 D	(I 134·8 (31) (II 108·3 18)	109·9 33 89·2 15	24·9** 19·1**
(Patiala) Maharaj	(I) 142·3 24 (II) 118·3 21	122·0 (32 101·7 (27	20·3** 16·6**
(Patiala) (No. 1)	I 134·8 (26 (II) 108·1 (23	118·8 (27 94·1 20	16·0** 14·0**
(Sind) A.O. 90	(I) 138·9 25) (II) 118·3 16	128·5 (24 99·7 23)	10·4* 18·6**
(Sind) C. S. I. R.	(I 151·4 34 (II 126·3 20	131·5 28) 110·1 27	19·9** 16·2**
(Bombay) Bansi (224)	(I) 100·5 32 (II) 95·8 (13)	89·6 (25) 85·6 23	10·9* 10·2**
(Madras) Samba	(I) 141·0 5 (II) 111·7 16	123·3 21) 102·1 12)	17·7* 11·5**

*Significant at 5% level; ** Significant at 1% level.

Almora. This difference can partly be attributed to the prevailing higher temperature ranges in New Delhi. Pending the results of another 150 strains of cultivated Indian wheat, we do not feel justified in offering any further generalisation.

Vivekananda Laboratory, Almora, and Imperial Agricultural Research Institute, New Delhi,
B. SEN.
S. C. CHAKRAVARTI.
B. P. PAUL.
G. S. MURTY.

November 13, 1946.

1. Kar, B. K., *Nature*, 1946, **157**, 811. 2. Sen, B., and Chakravarti, S. C., *Curr. Sci.*, 1945, **14**, 124. 3. —, *Indian J. Agric. Sci.*, 1942, **12**, 1. 4. Sen, B., *Indian Farming*, 1940, **1**, 55. 5. *Progress Report, I.C.A.R.* 1943–44. 6. —, 1944–45.

ON THE EFFECT OF DIFFERENT CROP ROTATIONS ON THE FIBRE PROPERTIES OF COTTON

IN the black cotton soil tracts of Marhatwada (H.E.H. the Nizam's Dominions), cotton is usually cultivated in rotation with either *kharif* or *rabi jowar* (*Sorghum vulgare* Pers.). In recent years, however, groundnut (*Archis hypogea*) is becoming popular for the purpose since the yields of cotton following this leguminous crop are generally higher than the ones obtainable after either *jowar*. To ascertain this belief a regular rotational experiment consisting of all these three crops in a two and three course systems has been in progress at the Cotton Research Station, Nanded, since 1941–42. It consists of four randomised blocks (individual plot size 1/66 acre) and five rotational treatments detailed below:—

(1) Cotton grown after *kharif jowar*;
(2) Cotton after *rabi jowar* following *mug*;
(3) Cotton after groundnut;
(4) Cotton after groundnut following *kharif jowar*; and
(5) Cotton after groundnut following *rabi jowar* and *mug*.

Gaorani 6 was the variety of cotton used. Further all the crops were grown strictly as per local practice.

During the course of this investigation it was considered desirable to know the effect of these rotational treatments on the fibre properties of cotton since these formed an important basis for determining its value from trade point of view. Accordingly, four-ounce lint samples obtained from each of the plots of the five different rotational treatments were tested for such fibre properties as have a considerable say in determining their spinning value. As such, mean fibre weight per fibre, mean fibre length (mm.) and mean fibre weight per unit length were examined by the usual methods.

The analyses of variance due to these rotation treatments for these different characters were as follows:—

Due to	Degrees of freedom	Variance or Mean Square		
		Mean fibre wt. per unit fibre 10^{-6} gm.	Mean fibre length mm.	Mean fibre wt. per cm. 10^{-6} gm.
Blocks	6	·0042	0·312	0·0017
Seasons	1	·0116	0·040	0·0087*
Rotations	4	·0235	0·157	0·0014
Seasons × Rotations	4	·0162	0·237	0·0012
Error ..	24	·0104	0·282	0·0018

* Significant at 5 per cent. level.

The above results clearly indicate that Gaorani 6 has the same fibre properties when grown either after *kharif jowar*, *rabi jowar* or groundnut and that the different crop rotations are not likely to affect the spinning quality of the following cotton crop.

Similar conclusions regarding the role of previous rotation crops on the fibre properties of the following cotton were arrived at by Gulati[1] (1941) and R. L. N. Iyengar[2] (1943).

The above work formed a part of the programme of work of Indian Central Cotton Committee Schemes at Nanded.

Cotton Research Station, Nanded, Hyderabad (Dn.), *December* 3, 1946.

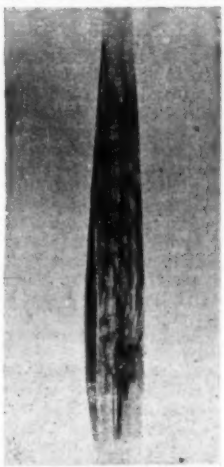
P. D. GADKARI.
K. G. DEO.

1. Gulati, A. N., "Influence of environment on yield, seed, etc., on P.A. 4F and P.A. 289 F/43," *Eighth Conf. of Tech. Assts.*, Matunga, 1941. 2. Iyengar, R. L. N., "*Fibre Properties of Cotton*," Thesis for D.Sc., of Madras, University, 1943, 137–38.

RHIZOCTONIA-LEAFSPOT, A NEW LEAF DISEASE OF SUGARCANE

A NEW leaf disease of sugarcane was noticed in Gopalpur (Bengal) on Co. 421. The disease has also been seen elsewhere before as is mentioned below. The symptoms observed were as follows:—

Beginning as a small dull red spot in the lamina towards one or the other side of the midrib, the symptom spreads in characteristic concentric zones. The zones are marked by wavy lines of dull red colour alternating with broader whitish areas in between. The spot spreads much faster along the length of the leaf than across it so that the spots are commonly found to be 4"5"-6" long and 2"-3" broad. The zones themselves have the thin wavy lines and the whitish zones much broader in the



regions above and below the origin than at the sides. This effect is clearly brought out in the figure.

The symptoms have a slight superficial resemblance to those of the "Banded Sclerotial Disease". Important differences exist, however, between the symptoms produced by the two diseases. While the alternating bands of red and white are common between the two and are suggestive of a close similarity, the dull red colour, and the zones developing in a characteristic concentric fashion from a point of origin on the surface of the lamina easily distinguish the disease described here from the Sclerotial Disease.

The symptoms are to be observed in the beginning of the monsoon season, in the first or second week of July, in both the diseases. But whereas the symptoms disappear in the crop by the end of August or the first week of September in the Sclerotial Disease, the symptoms described above may be seen in November and December in the leaves. The writer, for instance, has observed the symptoms in September-October 1941 in Ranchi, in November 1942 in Purtabpore, on Co. 513, and in October 1943 on Co. 513 and on Co. 313 in Pusa, in Bihar.

The most important distinguishing feature of the disease is, however, the presence of minute dark dots on the surface of the leaves which may be easily observed with the aid of a hand lens (× 10). They represent the dark irregular sclerotia of *Rhizoctonia*. Microscopic examination reveals that the sclerotia are partially embedded in the leaf tissues. The fungus is easily identified as *Rhizoctonia solani* Kuhn.

The disease is always confined to a few canes in a plantation. It does not seem to spread rapidly and is never found generally prevalent in an area or a field.

Dried specimens of the above disease are being deposited with the Herb. Crypt. Ind. Orient, New Delhi.

Directorate of Agriculture, Bengal, *October* 28, 1946.

S. Y. PADMANABHAN.

FLOWER COLOUR IN *STROBILANTHES DALHOUSIANUS* CLARKE AND *CYNOGLOSSUM MICROGLOCHIN* BENTH.

DURING a recent excursion to Dalhousie-Chamba-Ainpukhri, the writer has noticed a variation in flower colour in *Strobilanthes Dalhousianus* and *Cynoglossum microglochin* which it is thought worthwhile to place on record.

In *Strobilanthes Dalhousianus* Collet[1] reports the flower colour to be dark-blue while Hooker[3] states it to be purple. Along Dalhousie-Ainpukhri Road the species is abundant between 6,000-9,000 ft. Mostly the flowers are dark-blue. At one locality between Khajiar and Dalhousie a clone was observed with pure white flowers.

Cynoglossum microglochin Benth. grows between 7,000-11,000 ft. from Kashmir to Kumaon. According to Collet[1] flowers are dark-blue. Coventry[2] states the flower to be dark-blue or purple in Kashmir specimens. The species is exceedingly abundant at Ainpukhri (Chamba State). Most of the specimens possessed dark-blue flowers but quite a large number of plants were found to possess flowers milky-white in colour.

White-coloured flowers in *Strobilanthes Dalhousianus* or in *Cynoglossum microglochin* have not so far been reported.

Botany Department, Punjab University, Lahore, *December* 2, 1946.

P. N. MEHRA.

1. Collet, Col Sir H., *Flora Simlensis*, 1902. 2. Coventry, B. O., *Wild Flowers of Kashmir* (Series), III, 1931. 3. Hooker, Sir J. D., *The Flora of British India*, 1885. 4.

THE KARYOTYPE OF *CURCULIGO ORCHIOIDES* GAERTN., AND ITS RELATION TO THE KARYOTYPES IN OTHER AMARYLLIDACEAE

SATO (1938) in his masterly review of the various karyotype alterations and phylogeny in the Amaryllidaceæ has analysed (1) 19 genera in the Amaryllidioideæ showing a striking resemblance in their basic chromosome complement and number (*b*-11) except *Hæmanthus* (*b*-8) which points to a possible link with that of *Scilla* and of *Alstrœmeria*; (2) 5 genera under Agavoideæ resembling *Yucca*; (3) 2 genera under Hypoxidoideæ-*Alstrœmeria* (2*n*-16) and Bomalia (2*n*-18), showing a resemblance to *Hœmanthus* on one side and to *Scilla* on the other.

The present contribution on *Curculigo orchioides* Gærtn., a member included under the subfamily Hypoxidoideæ, is an attempt to compare its karyotype with those of other genera in the subfamily. Root-tips were collected from bulbs grown in the laboratory and fixed in Flemming's medium mixture. La Cour's modification of Newton's iodine-gentian-violet schedule was followed.

The karyotype revealed a diploid chromosome count of 18, as in *Bomalia salsilia*, although in general morphology it falls in line with the karyotypes of the Hypoxidoideæ with a diploid compliment of 16 chromosomes. Fig. 1

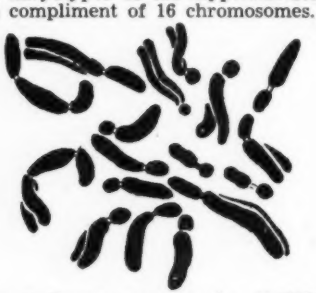


FIG. 1. Somatic metaphase plate × 4050

shows the 18 somatic chromosomes on the metaphase plate. They fall into one pair of long chromosomes with submedian constrictions, one pair of medium-sized chromosomes with secondary constrictions (denoted M^s) and seven pairs of short chromosomes with mostly submedian and subterminal constrictions. No satellites were detected.

Curculigo orchioides =

$$2n = 18 = 2L + 2M^s + 14S.$$

A study of this karyotype strongly suggests a phylogenetic similarity with that of the *Alstrœmeria* type and possibly of *Scilla*. A medium-sized chromosome with a secondary constriction is a feature common to both *Curculigo orchioides* and *Alstrœmeria pulchella*. Sato derives this chromosome of the latter by inversion of a short arm with a satellite of a long chromosome in *A. chilensis*. A similar origin for the medium-sized chromosome with a secondary constriction in *Curculigo orchioides* is now suggested. In general morphology, the karyotype of the species under examination shows an unmistakable resemblance to that of *Alstrœmeria pulchella*, except for the presence in the former of an extra pair of short chromosomes. The two pairs of short chromosomes of identical size and morphology

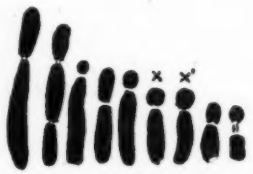


FIG. 2. Idiogram of the haploid complement × 4050

(denoted x and x') suggest that one of them is the reduplicated pair. Evidence for this suggestion would naturally lie in the behaviour of these pairs in meiosis and investigations to this end are in progress. The absence of satellites and the extremely terminal constrictions are features peculiar to the chromosomes of *Curculigo orchioides*.

Thanks are due to Dr. K. V. Srinath for guidance and criticism and to Dr. L. N. Rao for his encouragement.

Department of Botany,
Central College, AHMEDULLA SHERIFF.
Bangalore,
December 14, 1946.

1. Sato, D., *Cytologia*, 1938, **9**, 213-242.

TRANSPORT OF MILK IN WARM CONDITION

THE best means of encouraging milk production in the country is to find a ready market for the liquid milk at a reasonably fair price. Chap milk can only be produced in rural areas and means must be found to transport it in a wholesome condition to the consuming centres. The usual accepted method for keeping liquid milk in good condition is chilling up to 48-50° F. Considering our climatic conditions this is a costly method as the milk generally has to be cooled to about 50° F. below the atmospheric temperature. Recently Desai, *et al.* (1946) have suggested that milk can be kept wholesome for 16 hours by keeping it at 150° F. No change in the fat percentage and acidity of milk occurs when it is stored at this temperature for 16 hours. There was also a decrease in the bacterial count at this elevated temperature as compared to cold storage (50° F.). The milk, however, acquired a cooked flavour.

Even if milk can be kept in a marketable condition at 150° F. there is not much advantage in adopting this method as the cost is not likely to be very different from the cost of refrigeration. Investigations were, therefore, conducted to see if this temperature can be further reduced to that it may be as near to the average climatic conditions (100° F.) as possible. The aim was to find the temperature at which milk could be kept fresh for a period of about 48 hours, as this will give a wide scope for its transport to distant places.

In laboratory trials 200 ml. of milk was kept in sterile conical flask after raising it to the particular temperature under study. The flasks were plugged with cotton-wool. For each series six such flasks were used and removed one by one at different intervals. Effects of keeping milk at 86·0°, 98·6°, 113·0°, 122·0°, 131·0° and 143° F. (30·0°-61·7° C.) were studied over a period of 48 hours. The results obtained are shown below.

Effect on Milk by Keeping it at Different Temperatures

Sample Number	Milk used	Acidity (% lactic)				
		Initial	4 hrs.	8 hrs.	10 hrs.	24 hrs.
I.	*Milk kept at 86°F. (30°C.)*					
	1 Buffalo	0·11	0·11	0·11	0·13	0·65 C
	2 ,,	0·12	—	—	0·50C	—
	3 ,,	0·11	0·11	0·17	—	0·70
	4 ,,	0·12	—	—	0·44	—
	5 ,,	0·12	0·12	0·15	C	—
	6 ,,	0·12	0·12	0·15	—	C
	7 Cow	0·14	0·15	0·16	—	C
	8 ,,	0·12	0·13	0·21	—	C
	9 ,,	0·12	0·13	0·17	—	C
II.	*Milk kept at 98·6°F. (37°C.)*					
	1 Buffalo	0·11	0·11	0·12	—	0·62
	2 ,,	0·12	—	—	0·39	C
	3 ,,	0·11	0·11	0·16	—	0·66 C
	4 ,,	0·12	—	—	0·45C	—
	5 ,,	0·12	0·13	0·16	—	C
	6 ,,	0·12	0·13	0·17	—	C
	7 Cow	0·14	0·15	0·17	—	C
	8 ,,	0·12	0·13	0·24	—	C
	9 ,,	0·12	0·13	0·18	—	C
III	*Milk kept at 113°F. (45°C.)*					
	1 Buffalo	0·11	0·11	0·12	—	0·26 C
	2 ,,	0·12	0·12	—	0·41C	—
	3 ,,	0·11	0·11	0·13	—	0·42 C
	4 ,,	0·12	—	—	0·29	— C
	5 ,,	0·12	0·12	0·20	—	C
	6 ,,	0·12	0·12	0·16	—	C
	7 Cow	0·14	0·16	0·17	—	C
	8 ,,	0·12	0·13	0·27	—	C
	9 ,,	0·12	0·14	0·19	—	C
		Initial	6 hrs.	24 hrs.	30 hrs.	48 hrs.
IV	*Milk kept at 122°F. (50°C.)*					
	1 Buffalo	0·12	0·13	0·14	C	—
	2 ,,	0·13	0·13	0·13	C	—
	3 ,,	0·13	0·13	0·13	0·15	0·36
	4 ,,	0·13	0·13	0·36C	—	—
	5 Cow	0·14	0·14	0·14	0·14	C
	6 ,,	0·13	0·13	0·13	C	—
	7 ,,	0·13	0·13	0·13	C	—
	8 ,,	0·13	0·13	C		
V	*Milk kept at 131°F. (55°C.)*					
	1 Buffalo	0·12	0·12	0·13	0·13	0·13
	2 ,,	0·13	0·14	0·14	0·14	0·14
	3 ,,	0·13	0·13	0·13	0·14	0·14
	4 ,,	0·13	0·13	0·13	0·14	0·13
	5 Cow	0·14	0·14	0·14	0·14	0·14
	6 ,,	0·13	0·13	0·14	0·14	0·14
	7 ,,	0·13	0·13	0·13	0·13	0·13
	8 ,,	0·13	0·13	0·13	0·13	0·13
VI	*Milk kept at 143°F. (61·7°C.)*					
	1 Buffalo	0·12	0·12	0·12	0·12	0·13
	2 ,,	0·13	0·14	0·14	0·14	0·14
	3 ,,	0·13	0·13	0·13	0·13	0·13
	4 ,,	0·13	0·13	0·14	0·13	0·13
	5 Cow	0·14	0·15	0·15	0·15	C
	6 ,,	0·13	0·13	0·13	0·13	0·13
	7 ,,	0·13	0·13	00·13	0·13	0·13
	8 ,,	0·13	0·13	0·13	0·14	0·13

C = Curdled.

At temperatures up to 113° F. almost all the samples curdled within 24 hours. At 131°F. and 143° F., both cow and buffalo milk kept fairly well even up to 48 hours. There was little change in the acidity of milk.

The above studies were further extended using 2 litres of milk in closed tinned brass vessels instead of glass flasks. At 145° F. ± 4° F. it was found that about 85 per cent. of buffalo milk and 70 per cent. of cow milk samples curdled within 48 hours. Studies carried out at 130° ± 4° F., on the other hand, gave very promising results. In nine trials none of the samples curdled. There was no decrease in volume and no skin formation took place after keeping the samples for 48 hours. The samples had sweet flavour. The fat percentage of milk did not show any change.

The above studies are being further extended with larger quantities of milk and it seems reasonable to expect that when dealing with greater bulk of milk it will be possible to reduce the temperature below 130° F. ± 4° F. and thus provide a simple and economic method for the transport of milk from rural to urban centres.

C. P. Anantakrishnan.
Noshir N. Dastur.
Zal R. Kothavalla.
Imperial Dairy Research Institute,
Bangalore,
November 13, 1946.

1. Desai, K. K., Thakre, G. S. and Sen, K. C., *Ind. J. Vet. Sci. and Animal Husbandry*, 1946. *in print.*

BACTERIAL LEAF-SPOT ON ARUM

During July 1944 in almost all the vegetable-growing areas of Nagpur, leaves of arum (*Colocasia antiquorum* Schott) were found spotted all over the surface, which on examination, proved to be due to some bacteria. As far as known to the author, the bacterial leaf-spot disease of arum has not so far been reported from anywhere else. A few bacterial diseases have been recorded on different species of *Colocasia* and *Alocasia*. Jones[3] (1901) reported that *Bacillus carotovorus* Jones [now according to International rules changed to *Bacterium aroideæ* (Towns) Stapp.], caused a rapidly progressing soft wet rot of roots, rhizomes, fruits and fleshy stems of vegetables and other plants; *Alocasia macrorrhiza* and *Colocasia esculenta* were also attacked by this organism. Ciferri[1] (1927) states that inoculation experiments with a strain of *Bacillus carotovorus* (*Bacterium aroideæ*), isolated from the rotted rhizomes of *Xanthosoma sagitifolium*, gave positive results on the original host as well as on *Colocasia antiquorum*, *Alocasia macrorrhiza*, etc. In 1936, it has been reported from Hawaii that *Colocasia esculenta* is subject to two major corm rots, one a soft rot associated with an unidentified *Pythium* and with *Phytophthora colocasia*, frequently accompanied in a secondary capacity by *Bacillus carotovorus* (= *Bacterium aroideæ*). All attempts to reproduce the typical features of the rot, as observed in field by Parris[4] (1936), gave negative results, and the development of the disease is believed to be due to the combined action of either or both the above-mentioned weakly parasitic Phycomycetes and unfavourable soil conditions.

The bacterial leaf-spot disease has been found to occur on *Colocasia antiquorum* Schott, and *Alocasia indica* Schott, the leaves and rhizomes of which are extensively used as vegetables in the Central Provinces and Berar. The disease has been found to cause considerable loss as the leaves become unfit for human consumption and the yield of the corms are appreciably reduced.

The first symptom of the disease is the occurrence of minute, round to oval, dark sage-green coloured spots which are roughly arranged in streaks all over the upper surface. During rainy season these spots are mostly localised on the upper surface of the leaves, only a few scattered ones on the lower side, but during winter they are equally prominent on both the sides. The spots on the upper surface of the leaves are dark sage-green in colour while on the lower surface as eucalyptus green[2] but they are similar in their nature of growth and size. Corresponding yellowing or marking on the opposite sides are not found in either case. Within three to four weeks these spots become larger in size, varying from 0·5 mm. to 1 cm. in diameter, and invariably coalesce later to form larger patches. With the advance of the disease the colour changes to light yellow and then light brown. Such affected leaves lose their lustre and drying starts from the periphery towards the centre. After a few days the leaves die. Excess of soil and atmospheric humidity are most favourable for the spread of the disease. Younger leaves were more susceptible to the disease than the older ones.

The pathogen was isolated from the infected leaves and pure cultures were maintained on glucose-agar tubes where the growth appeared within 24 hours. By inoculating, the disease could be artificially reproduced in its natural conditions. The infection could be induced on the lower as well as on the upper side of the leaves. The disease appeared within 24 hours on the lower side and after 48 hours on the upper side during rainy months and after 3 to 4 days during winter season. On reisolation the same organism was always obtained. It was observed that primary symptoms appeared when small quantities of the organism were placed on healthy leaves while by placing larger amounts the secondary effects were produced. In cross-sections the bacterium was noticed in the parenchymatous tissues and in the palisade cells.

On glucose agar medium the organism formed round, smooth and depressed colonies, varying from 0·5 mm. to 4 mm. in diameter. The bacterium is motile, highly refractive and rod-shaped, varying in its size from 1·33 to 3·13 μ in length and 0·66 to 1·33 μ in breadth, the average measurements being 2·13 μ × 0·93 μ. Growth on agar-agar streaks is smooth, soft and of spreading type with slimy surface having fine ridges. The organism has so far not been identified.

Further work is in progress.

Mycology Section,
Agric. Research Institute, R. P. Asthana.
Nagpur,
November 22, 1946.

1. Ciferri, R., "Notæ mycologicæ et phytopathologicæ," Series II, N. 1–15, *Riv. Patol Veg.*, 1927. **17**, 209, 94. 2. Dauthenay, H., *Repertoire de Couleurs.* 3. Jones, L. R., *Vermont Agrl. Exp. Sta Report*, 1901, **13**, 299–332 4. Parris, G. K., *Rep. Hawaii, Agri. Exp. Sta.*, 1936, p. 33–40.

REVIEWS

METALS AND ALLOYS*

THE following remarks culled from the opening pages of the two books under review indicate the need which they endeavour to fill, in different ways, for a presentation of the subject of metallurgy from the newer points of view :

"X-ray metallography is proving itself to be an essential tool in metallurgical research. It is taking its place beside the classical thermal and microscopical methods which have proved to be so valuable to the study of metals and alloys. It supplements these methods rather than replaces them, the combination of all being the ideal to aim at. X-ray analysis has almost been entirely developed by physicists who have been handicapped by their lack of metallurgical experience. The metallurgist's wide knowledge of the behaviour and characteristics of alloys is beyond the reach of the physicist, and he must look to his colleagues to appreciate the uses to which the new tool he has developed can be put." * * *

"The scientific study of the structure of alloys was first developed by the physical chemist and by the metallurgist. It is now tending to become the province of the physicist and the mathematician. The student who is interested in this important subject is often inclined to feel that, until he has specialised in all these branches, he cannot hope to understand its recent developments." * * *

The smaller volume by Benyon is intended as an introduction to the modern physico-chemical theories of the structure of alloys. Its aim is to present the "subject-matter in such a way that it will be of direct use to practising and student metallurgists and to similar groups of chemists and physicists who are becoming increasingly concerned with metals and alloys; as also to convey to students of metallurgy, chemistry and physics, a broad outline of the contributions made within recent years towards the solving of what were some of the bewildering problems of the science of alloys". Considered from the standpoint of these aims, the book can claim to have achieved a considerable measure of success and may be heartily commended.

Dr. Taylor's volume is a more ambitious production. It is intended both as a systematic treatise and as a book of reference regarding the use of X-ray analysis as a tool in metallurgical research, and covers the field indicated by these aims in a systematic and thorough fashion. About a third of the book is devoted to the presentation of the fundamental theory and experimental technique of crystal structure analysis by the X-ray method. The eighth, ninth and tenth chapters of the book deal with the study by X-ray methods of the metallographically important topics of thermal equilibrium diagrams, measurement of grain size and grain orientation. Two chapters follow, dealing respectively with the application of X-rays to the study of refracting materials and with radiography and the micro-radiograph. No less than seventy pages are devoted to an Appendix containing numerous tables and data useful to those engaged in X-ray studies and metallographic research. The book will be appreciated by all X-ray workers and metallurgists, and may be read with profit also by those who are not specialists in these fields, but are interested generally in the technical achievements of modern science.

C. V. RAMAN.

* *The Physical Structure of Alloys*. By C. E. Benyon. 126 Pages octavo; London: Edward Arnold & Co., 1945. Price 6/6 net.

* *An Introduction to X-Ray Metallography*. By A. Taylor, with a Foreword by Sir Lawrence Bragg. 400 Pages Royal octavo; London: Chapman & Hall, 1945. Price 36/- net.

The Diffraction of X-Rays and Electrons by Free Molecules. By M. H. Pirenne. (Cambridge University Press), 1946. Pp. 1-160 + xii. Price 12*sh.* 6d.

X-ray and electron diffraction studies have, in recent years, been developed into a powerful tool for the elucidation of molecular structure. Although the theoretical basis of the diffraction of X-rays by atoms and molecules was developed by Debye as early as 1915, it required several refinements in the theory before the experimental results could be utilised for determining the structure of molecules. The most important of these is the realisation that the incoherent Compton scattering forms a significant part of the total scattering. The theoretical ideas have now been developed to such an extent that it has been possible to detect the influence of thermal atomic vibrations on the diffraction curve of a molecule, at least in one instance. Another notable use of the diffraction of X-rays is in the study of the liquid state, which has resulted in the discovery of the quasi-crystalline nature of liquids in general.

The book under review deals with these and various other aspects of the subject in a brief and highly stimulating manner. As Prof. Debye remarks in his preface to the book, "It contains all essential information about a subject intimately connected with our understanding of molecular structure". For a book of only 160 pages, the large variety of topics discussed must be considered remarkable. This has been achieved by reducing mathematical details to the minimum; but this has not resulted in a lack of rigour or precision in the treatment. The chapter on experimental methods will provide valuable hints for the construction and use of the apparatus required in those studies. A complete bibliography is also included of papers published on X-ray diffraction by gases

and also of all determinations of molecular structure made by this method. The book will certainly prove to be a highly useful companion to all those engaged in research work on X-ray and electron diffraction.

G. N. RAMACHANDRAN.

The Indian Textile Industry (1945-46) Annual (Messrs. Gandhi & Co., Publishers, Jan Mansion, Fort, Bombay), is one of its interesting annual series brought out by Mr. M. P. Gandhi, its Founder-Editor.

The main features of the *Annual* include a well presented review of the industry's progress during the year 1945-46 from all aspects, the ppresent financial and economic position of the industry and its future outlook. It also gives as usual an overall picture of the industry with authoritative and up-to-date statistical tables and the scope it provides for further planned development of the industry under a well-guided national policy.

The volume also deals critically with the various legislative measures on the anvil of the Government of India for improving the conditions of labour estimated to cost as much as twelve rupees per month per operative. While recognising the necessity of improving the lot of labour it cautions the Government against forcing the pace of reforms beyond a limit in these fluid times.

The editor also draws pointed attention to the growing competition of rayon—cotton's chief rival—to the cotton textile industry. Far from looking on rayon with a hostile eye the industry could do well to adapt itself to an extended use of this synthetic material thereby making available a larger range of textiles to the common man. He advocates the abolition of the excise duty on imported raw cotton as he believes it imposes a needless handicap on the competing capacity of the industry as against foreign manufacturers. While one may agree with this as an expedient, its wisdom as a permanent policy is to be doubted, as it operates as a deterrant to cultivators of long-stapled varieties of raw cotton at home with our present uneconomic methods of cultivation.

The book concludes with three appendices, one relating to raw cotton, its cultivation, export, import and consumption in the country; the second, regarding the present position of the handloom industry and its future in relation to mill industry; and the third gives a complete up-to-date list of cotton mills working in India. The chapter on handloom industry is very illuminating and provides interesting reading. The author has freely drawn upon official views and reports in order to complete the picture of the subject.

An important omission as it strikes one after going through the volume, is its failure to take into account the necessity and urgent importance of manufacture of textile machinery and the need for the active encouragement of other complementary and ancillary industries. In this respect the present state of affairs is a sad commentary on the lack of interest displayed by the textile industry and the apathy shown by the Government. India appears to be blissfully content with producing cotton and converting it into textiles with little or no thought bestowed on the manufacture of machinery and necessary essential stores. The author would do well to stress this important aspect of the industry by giving necessary information and statistical data. If even the existing sources and facilities in the country were to be fully harnessed in a well planned and co-ordinated effort much could be done in the matter of supply of urgently needed requirements of the industry and in the matter of reconditioning the already overworked plant.

On the whole, the volume should prove very useful and interesting to every one interested in the textile industry both as an annual refresher and as a handy-book of reference.

B. G. R.

WATER TRANSPORT*

FROM the earliest times man has devised a variety of means of transport over water beginning with the simple log of wood which helped him float down the stream near his habitation. The subsequent discovery of means of propulsion by the use of logs whilst astride a floating log led to the use of paddles and oars. Combination of floats led to rafts, catamarans and such composite gear, while the single log gave place to floating pots, baskets, bark canoes, coracles and the dug-outs. These variations, steadily modified and improved upon by different peoples in different parts of the world, provide the large number of types of water transport we now encounter. Some of these have made little improvement on the primitive pattern while others evolved in different directions in accordance with the requirements and conditions of life of their users. The source of raw material for building them has also profoundly influenced the modifications. It is often difficult to assess the relationship between one type and another because, as judged by the present-day craft, the story is not continuous but one full of gaps. The object of the author has been to set forth in detail the numerous types of water transport perfected by man from the earliest times till the advent of the Sailing Boat and the subsequent introduction of steam and internal combustion engines and to indicate the evolutionary changes which have taken place in these Craft. The subject is of great interest as it throws much light on the wanderings of people in ancient times.

In the accomplishment of this difficult task of compiling information on the Craft now in use and connecting it with the notes and observations of numerous historians and travellers, Hornell's first-hand knowledge of most of the modern Craft in use has been invaluable. He spent some years in Ceylon in charge of Pearl

* *Water Transport: Origins and Early Evolution.* By James Hornell. Pp. xv + 1-307; Pls. I-XLV; I Map and 69 Text Illustrations. Cambridge University Press, 1946. 30 *sh.* net.

Fishing operations in the Gulf of Manaar, an industry which attracts many groups of maritime fishermen with the most diverse craft and gear. A long period of Fishery Administration in the Province of Madras which followed enabled him to observe the fishing vessels in use in different parts of India. He undertook long journeys in Malaya, Indonesia and Japan, all most fruitful to the object of his study. He has been able to observe most of the Craft he describes in their work-a-day occupations by people belonging to different stages of civilization and material culture. This fortunate combination of his interests and the opportunities offered by his occupation has given this very readable and illuminating account of river, lake and sea-craft—a work which is the result not of armchair scholarship but of extensive and accurate field observation.

Hornell has arranged his material in three main sections devoted to three broad types into which the Craft may be classified. The first of these deals with floats, rafts and kindred craft. This includes the most primitive agencies of water transport; swimming and riding floats of various types are to be seen in use even at the present day as, for example, the buoyant blocks of wood used by fishermen in the Lower Kaveri and the Godavari, and the round-bottomed earthenware jars or *Pallachatties* used by the Sind fishermen in their pursuit of Hilsa. Gourds are used in many countries in the place of pots. Another variant is the inflated skin float which is of great antiquity, being depicted in sculptures from Nimrud and Ninevah and, in fact, associated with most subsequent civilizations of the Mediterranean region. An improvement of the simple float is that which is ridden astride, several variations of which occur. Another line of evolution has been the combination of floats as rafts, either of the earthenware pots or of inflated skins; Chatty rafts of various kinds are known from different parts of India. In a different category are the reed rafts and reed Canoes of worldwide distribution but among which the graceful reed balsas of Lake Titicaca in S. America form a highly specialized type. Among the first group, the most specialized are no doubt the log rafts and catamarans so peculiar to the surf-beaten Coromandel Coast of India showing great variations in structure chiefly to suit the particular type of fishing for which they are employed. Sea rafts of various patterns are found all along the Indo-Pacific extending to S. America. Describing these various modifications leading up to the construction of the Chinese Sampans, Hornell concludes that Sampans and Junks are descendants of shaped and specialized rafts rather than of Canoes.

Skin boats like coracles, curraghs, kayaks and their kin are dealt with in the second section; these boats, which have the common characteristic of a light framework and covering by hide or some cloth, are widely yet discontinuously distributed in Asia, Europe and North America while none is encountered in Africa; its occurrence in S. America (the *Pelota* of La Plata) is probably by a recent introduction. Indian coracles are different in construction from the other varieties and are found only on the Kaveri, the Thungabhadra and the Kistna. Once we pass the Deccan they reappear only in Tibet; they are absent from Persia and Afghanistan while in Eastern Bengal, their place is taken by the earthenware *tigari* which serves a similar purpose. In middle China and Japan it has modified into wooden tub-boats; a modified basket-boat is met with in Indo-China. The true coracle again reappears in Iraq. After detailed accounts of these, Hornell describes at some length, the British coracles and Irish curraghs giving notes on their historical and literary associations and folklore. This is followed by notes on the American coracles. The most specialized skin boats in existence are those used by the Eskimos; the roomy *Umiak* which is a large open boat, deep-sided and capable of carrying passengers and cargo, and the light, canoe-like *Kayak* which is mostly constructed to take a single person. Describing these in detail, the author deals with the origin of the skin boats and the evidences which are brought forward are of great interest. Discarding the possibility of a single theory to explain the origin and evolution of all skin boats, Hornell considers that while it is essential to recognise at least four different types, *viz.*, the coracle, the curragh, the *Umiak* and the *Kayak*, it is possible that the first three have a common denominator. The coracle being worldwide in distribution (Africa excepted) and, notwithstanding the possibility of independent invention in different localities as probably shown by the S. American *Pelota*, originated very early in man's cultural history. It is indicated that Central Asia was the probable area where the coracle originated and flourished under conditions where timber was in short supply but was slowly displaced by larger and heavier wooden craft in places like India with an abundance of fine timber.

The Bark Canoes, Dug-outs and Plank-built Craft are dealt with in the third section. In a discussion on the genetic relations of the Bark Canoe, the Dug-outs and the Plank-built boats it is pointed out that, though both the Clinker and Carvel types of plank-built craft are ultimately derived from the dug-out canoe, the latter type possibly represents only an intermediate stage in the evolution of the plank-built boats. Hornell develops this idea by indicating that the bark canoe is possibly the most ancient and the dug-out possibly evolved only as an improvement on the former, some of the modern dug-outs like the Malabar canoe even presenting vestigial relics of the bark canoe framework in the form of rib-like inner ridges. In tracing the evolution of the plank-built craft the stages are (*a*) the trough-shaped bark canoes, (*b*) sharp-ended bark canoes, (*c*) dug-out canoes and finally (*d*) the plank-built canoes. The modifications adopted in the change from the dug-out to the Carvel-built ship are worked out and a similar account is drawn up for the evolution of the Clinker-built fishing lugger. Constructional parallels in Scandinavian and Oceanic boats are traced and chapters dealing with the sailing ships of Ancient Egypt, the development of Arab ship design, the various types of boats found on the Ganges and the outrigger devices are included.

The last mentioned is of particular interest to India owing to the prevalence of outrigger canoes on the West Coast of India with a probable centre of distribution in the Ratnagiri and Konkan Coasts where they are often operated with Rampani nets. Outrigger devices are of two kinds, either the double outrigger where there is one accessory float on each side connected to the boat by balancing booms or the second type where there is only one outrigger and a pair of booms connected only to one side. The double outrigger is found in the Philippines, Indonesian Islands, Malaya, Madagascar and the East Coast of Africa, whereas the single outrigger occurs in India, Ceylon and in the large number of Pacific Islands. Contrary to the popular belief Hornell points out that the most primitive of the two is the double outrigger canoe, the single one having been a special adaptation to suit sailing in the open and rough seas. The last chapter is devoted to the numerous socio-religious and superstitious practices connected with the launching of boats and the significance of Oculi and other marks in boats in certain areas and their possible causes for absence from others. In addition to the numerous plates at the end of the book and text-figures mostly from the author's pen, there is an excellent bibliography and a map showing the distribution of the principal types of primitive water-craft.

Both the author and the Cambridge University Press deserve great praise for the publication of such a well-got-up and documented book which will be of equal interest to the general reader and to the serious student of that ill-defined borderland between history and anthropology.

N. K. PANIKKAR.

SCIENCE NOTES AND NEWS

PROF. C. K. INGOLD, F.R.S., has been awarded the Davy Medal of the Royal Society.

ELMER DREW MERRILL, Sc.D., LL.D., Arnold Professor of Botany at Harvard University, formerly Director, Bureau of Science, Manila, Dean, College of Agriculture, University of California, Director, New York Botanical Garden, Administrator of Botanical Collections, Harvard University, and Director, Arnold Arboretum, was seventy years old on October 13, 1946. At the occasion of the birthday anniversary of the *American Linnaeus* a special dedicatory number has been issued of the *Journal of the Arnold Arboretum*, edited by A. C. SMITH, to which colleagues all over the world have contributed. Early in October a special double issue of *Chronica Botanica*, edited by Frans Verdoorn, was published in honour of Dr. MERRILL. This 266-page number, entitled *Merrilleana*, consists of an authorized collection of reprints of DR. MERRILL'S principal general writings, as well as a chronological biography, and bibliography.

RAI BAHADUR A. N. KHOSLA, I.S.E., Consulting Engineer with the Government of India, and Chairman, Central Waterways, Irrigation and Navigation Commission, who represented India in the Executive Committee of the International Commission on High Dams, held recently in France, was elected one of their Vice-Presidents.

At the instance of the Government of India Mr. Khosla extended an invitation to the Executive Committee of the International Commission on High Dams to hold their next (1947) session in India. Since they had already accepted the invitations from Holland to hold their session in 1947 and from Sweden in 1948, the Committee is reported to have accepted in principle the invitation to hold their 1950 session in India.

It is expected that an International Commission on Irrigation and Canals will, when formed, choose to establish its headquarters in India. Mr. Khosla who attended the International Commission on High Dams on behalf of the Government, discussed this problem with the members of the Executive Committee of the International Commission on High Dams as also with the Commissioner of the U.S. Bureau of Reclamation in Washington, U.S.A., who have extended their strong support to this proposal.

Soap manufacturers of South India have formed themselves into an Association under the name of *"South India Soap Makers' Association"* with Registered Office at Calicut, at the first General Meeting held in Calicut on the 3rd November 1946, under the presidency of Rao Sahib A. K. Menon.

The aims and objects of the Association are to protect the soap industry in general, to work for the growth and development of the industry, to educate the public in the use of soap, to standardise the quality, to take joint action in the matter of legislation, and do such other things in the interests of the organised industry.

ERRATA

Vol. 15, *No.* 11, *November* 1946

Page 306, Note on "Synthesis of Folic Acid", para 3, line 4: *for* "2, 4, 5-triamino-6-hydroxy pyridine" *read* "2, 4, 5-triamino-6-hydroxy pyrimidine". Para 6, line 13: *for* "was found to contain" *read* "were found to contain".

Page 318, Note entitled "Nitrogenous Fertilisers in Relation to the Keeping Quality of Potatoes": In the table, the data under Manured and Unmanured Plots, *read* "Unmanured" *for* "Manured" and *vice versa*.

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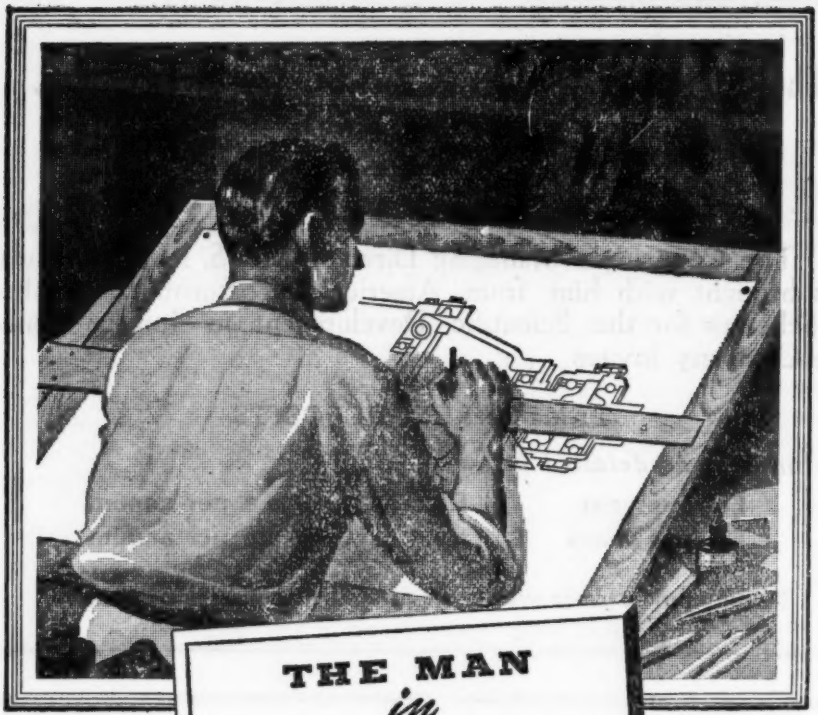

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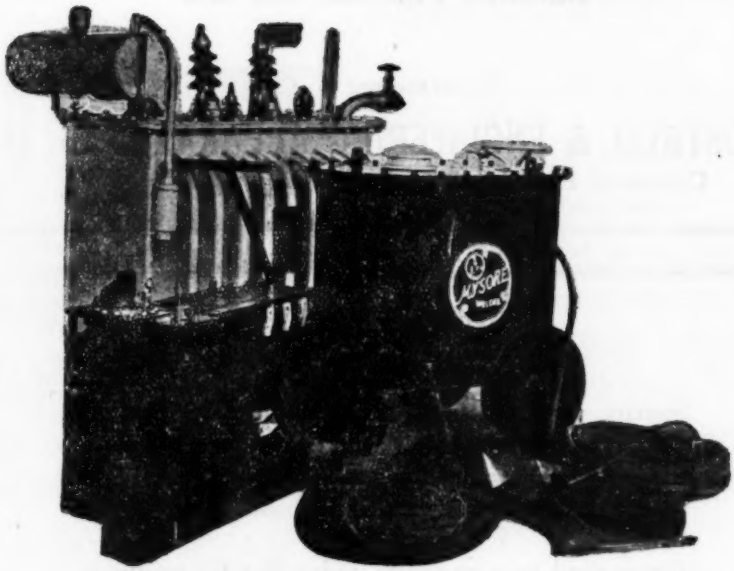

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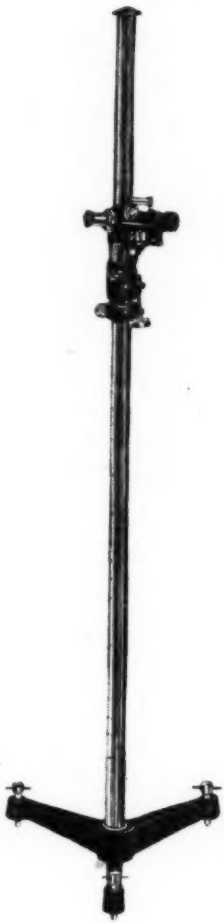

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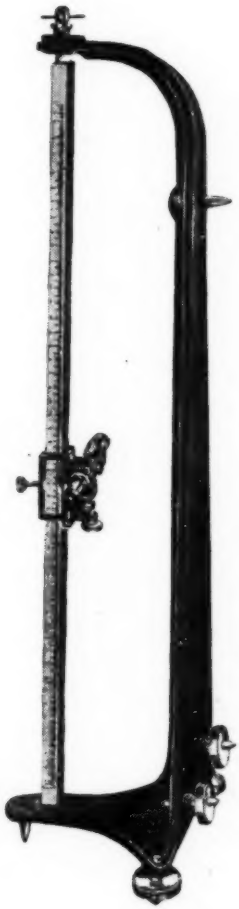

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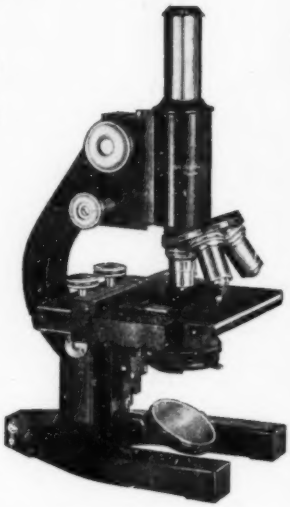

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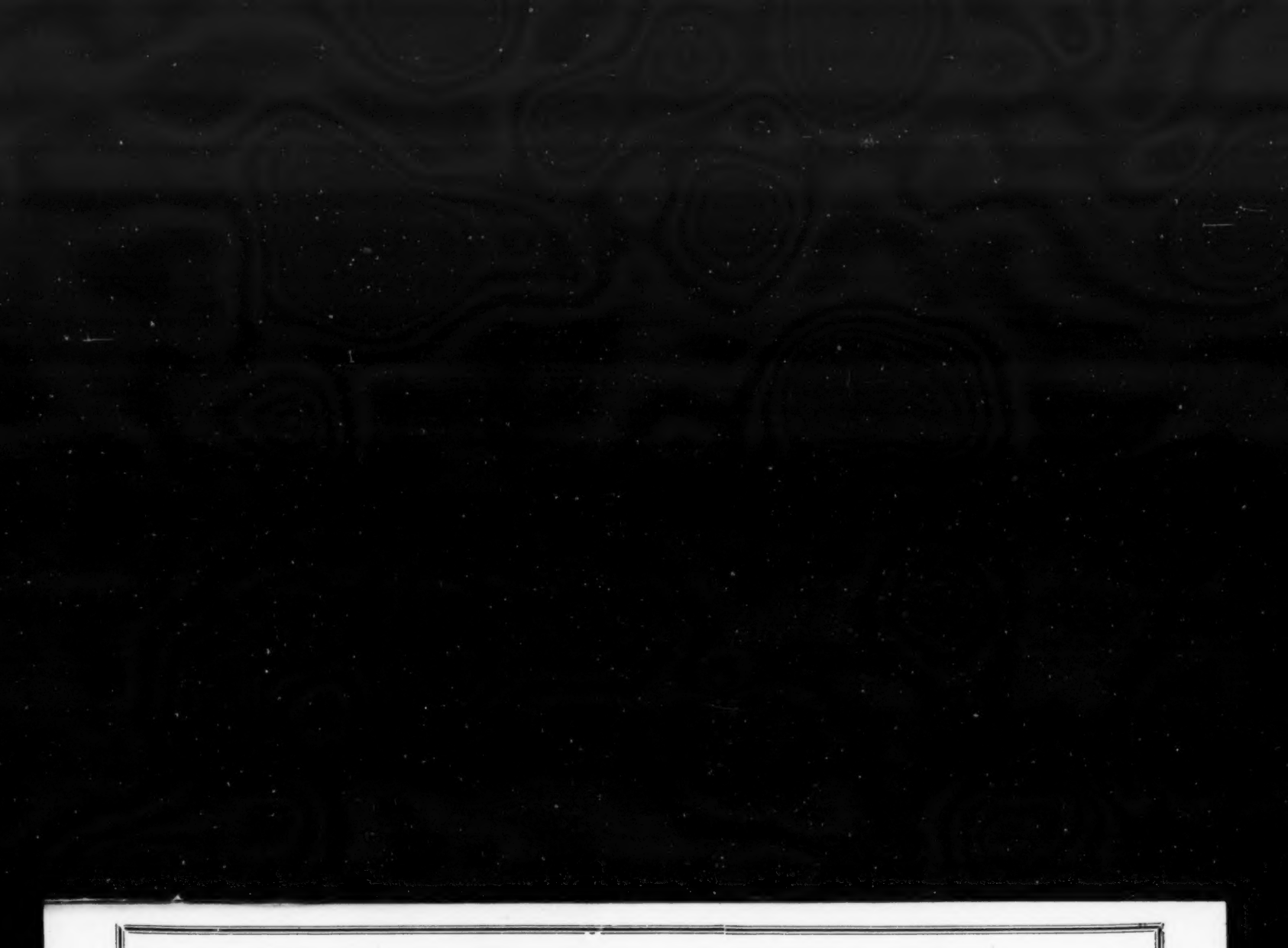
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